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LAKE VICTORIA ENVIRONMENT MANAGEMENT PROJECT

STAKEHOLDER WORKSHOP ON LAKE VICTORIA BASIN AND LVEMP 1 STOCK TAKING

8TH – 10TH SEPTEMBER 2003

NATIONAL SECRETARIAT
LAKE VICTORIA ENVIRONMENTAL MANAGEMENT PROJECT (LAVEMP)
MINISTRY OF WATER, LANDS AND ENVIRONMENT

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STAKEHOLDERS WORKSHOP ON LAKE VICTORIA BASIN AND LVEMP 1 STOCK TAKING

8TH – 10TH SEPTEMBER, 2003 - ARUSHA

As you are already aware, preparations are going on for the Stockholders Workshop on Lake Victoria Basin and LVEMP 1 Stock Taking, to be hosted by the East African Community (EAC) secretariat in Arusha, from 8th to 10th September, 2003. Up to 150 participants from different parts of the world are expected to attend the Workshop. LVEMP (Uganda) was given a slot of 14 people although, overall, some 30 people will be coming from Uganda.

The objectives of the workshop will be:

- To review progress and lessons learned from LVEMP 1
- To develop a concept for LVEMP 2 including key objectives, comments, and activities.
- To agree on a basic project preparation plan, and
- To discuss bridging period arrangements.

Key inputs to the workshop will be:

- Stocktaking report and lessons learned from LVEMP 1.
- Report of the Vision and Strategy for Lake Victoria Basin.
- Draft Concept Document for LVEMP 2

While the Vision and Strategy Report is a final one, the Regional Stocktaking document, a copy of which you already have, is a final one to be finalized soon after inclusion of

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Science and the Lake Victoria Environment Management Program (LVEMP); Progress during LVEMP 1 and Challenges for the Future.

By R.E. Hecky

Executive summary to be added

Introduction

In 1996 the World Bank (WB) and Global Environmental Facility (GEF) in response to a proposal from the three riparian countries around Lake Victoria provided funding to initiate the Lake Victoria Environmental Management Program in order to address concerns about detrimental changes in the lake environment. The most visible changes in the lake were dramatic increases in fish yields after the introduction of the Nile perch, increased algal abundance and reduced transparency, rapid spreading of the exotic water hyacinth, and reduced populations of endemic and native fishes. Less visible, but in some ways more threatening, were the potential for toxic and microbial pollution from agrochemical use, industrial and municipal effluents, toxic algae and increases in water borne disease incidence as water quality was degraded. All these changes whether separately, but especially in aggregate, threatened the sustainability of the many beneficial uses of Lake Victoria for fish exports, food production, drinking and domestic water, agricultural water use, hydroelectric power production, and transportation. In most cases, there are no alternatives (or only very costly alternatives) available to replace the beneficial services the lake provides and the loss of these services would certainly aggravate the social and economic condition of the riparian peoples. Therefore the objectives of LVEMP according to the Staff Appraisal Report (SAR) were to: *a) maximize the sustainable benefits to riparian communities from using resources within the base to generate food, employment and income, supply safe water, and sustain a disease-free environment; and b) conserve biodiversity and genetic resources for the benefit of the riparian communities and the global community.* The SAR also recognized that Victoria was an internationally shared lake that would require a strong and objective information base, effective collaborative management structures and harmonization of national management programs to effect agreed upon management objectives and sustainable use.

Preparation of the next phase of LVEMP is being led by the bank in response to the request of the national governments to continue to strengthen the environmental management of the Lake Victoria ecosystem that includes the lake, its basin and all the human activities affecting it. Part of that preparation is a stocktaking of achievements during the first phase of LVEMP. LVEMP is a complex project with a broad range of activities extending from institution building through aquatic research to soil conservation practice. LVEMP is in fact a response to concern about the condition of the lake by the riparian peoples, but especially as articulated by regional and international scientists who provide objective measures of the changes in the lake. Science played a role in the creation of LVEMP and science is fundamental to LVEMP meeting its long term objectives of sustainable use of the basin and the lake's resources to insure the benefits of the lake to present and future generations. As part of a series of stocktaking assessments of LVEMP, this report will review the achievements of science relative to

the objectives and described activities in the SAR. The focus of this report will be specifically LVEMP funded activities and research; however, the relevant contributions of scientific research outside LVEMP will also be highlighted to the extent that they contributed to the accomplishment of the LVEMP objectives. This scientific stocktaking review will start with a short review of the role that science generally plays in ecosystem management. It will then address the challenges to science posed by the Victoria ecosystem and systematically the achievements realized under the categories identified in the SAR: lake biota (and fisheries), water hyacinth, eutrophication and water pollution. Lastly the report will specifically identify: 1) activities that require continued support as monitorable indicators of progress in LVEMP, 2) unmet requirements residual from the first phase of LVEMP that still need scientific research, 3) and emerging issues not fully recognized in the SAR that should be considered in the preparation of the second phase of LVEMP.

The role of science in aquatic ecosystem management

The global science community especially in Europe and North America has long experience with many of the issues confronting Lake Victoria. Exotic introductions, eutrophication, and contamination by industrial and agrochemical pollution have affected several of the great lakes of North America as well as many other smaller lakes and water bodies. These environmental changes, just as in the Victoria basin, were driven by increasing populations, their necessary activities, and economic development (Bogue 2000). In the first half of the last century, the introduction of the sea lamprey into the North American Great Lakes decimated native fish populations that were already under stress from overexploitation. In the 1960's, Lake Erie was pronounced to be "dying", and in the early 1970's the Erie commercial fishery was closed for several years because of mercury pollution. Most of the North American Great Lakes have fish consumption advisories recommending against too frequent consumption of predatory fishes because of their contaminant burdens. Many of these contaminants are no longer produced in North America, but their legacy of contamination will last for several decades because they are efficiently cycle in lake food webs.

Through scientific studies and the achievement of science-based management objectives, there have been notable successes in managing and recovering even large lakes. For example Lake Erie is alive and flourishing today (Sweeney 1993). Eutrophication was reversed, and it currently has the most productive freshwater lake fishery in the world after Lake Victoria. Mercury was removed from many industrial processes in the industrialized Erie basin, and the fish today are suitable for commercial sale. Sea lampreys have been reduced in abundance through the use of larvacidal compounds, and populations of many native species are increasing under careful fisheries management (Brown et al. 1999). Reversal of undesirable trends and restoration of beneficial services even in great lakes is possible if there is adequate understanding of the ecosystems and the constituent biological populations. The foundation of effective management is sound science; and, if LVEMP seeks to repeat the successes achieved in other great lakes, the science must be the best possible. Consequently LVEMP also had to ensure the development of the scientific capacity to address the range of environmental issues on the lake as well as strengthening and harmonizing environmental regulation.

The Challenges to Science in the Lake Victoria Ecosystem

Given that there has been a long experience with many of the general issues confronting Lake Victoria in the early 1990's, one might ask if there is really a need for science in LVEMP. The answer is yes. Lake Victoria has very different climatic, hydrologic, chemical, physical and biologic properties than the temperate great lakes that have received most of the attention of the global science community. The lake itself is the product of a fine hydrologic balance. Its immense surface area of over 68,800 km^2 is second only to Lake Superior, but the mean annual temperature of Lake Superior is <4 C while Lake Victoria is approximately 25 C. As a consequence evaporative losses are very high and account for 80% of the water loss from the lake; conversely no other lake is so dependent on direct precipitation on its surface, 80% of total inputs. Victoria is the most dilute of all the great lakes because of the importance of rain in the water budget and it will be the most vulnerable to atmospheric pollutants. High temperatures also lower the solubility of oxygen and accelerate oxygen consuming processes making the lake more susceptible to deoxygenation than the temperate great lakes (Hecky 2000). Tropical lake circulation is still poorly known. It is complicated by the sensitivity of density change to temperature change at the high temperatures of tropical lakes and the weakness of geostrophic forces in a lake set on the equator. These two properties which largely dictate vertical and horizontal circulation in temperate lakes are much more problematic in their dynamics in tropical lakes.

The low-slope topography around Victoria allows wetlands, particularly papyrus the most productive plant community known, to be more extensive in Victoria than any other great lake. The wetlands have the capacity to modify incoming water quality to the lake and may provide important protection, if properly managed, against river borne pollutants of agricultural, municipal and industrial origin. While the algal productivity of temperate great lakes has been shown to be dependent on phosphorus (P) loading allowing eutrophication to be reversed by P control, it has been suggested that Victoria and other tropical great lakes may be nitrogen limited (Talling and Talling 1965) and may require a different approach to nutrient management.

The fish community of Victoria was highly diverse (estimates of 545 species: Snoeks 2001); and, even after probable extinctions due to Nile perch introduction and water quality change, it has at least twice as many species in it as *all* the North American Great Lakes combined (158 native species; Coon 1999) and new species continue to be found. This high diversity is a challenge to classical fisheries management that emphasizes management based on individual population dynamics although fishing practices can harvest many species at once. Maintaining this high diversity was a specific objective of LVEMP, but it is a unique challenge to science because protection of fish diversity has not been demonstrably successful anywhere else in the world. This is aggravated by a poor understanding among evolutionary biologists as to the ecosystem properties that allow the expression of such high biodiversity in tropical great lakes. The size of the Victoria basin, its long and divers shoreline, and its complex history of reversed drainages and climatically driven water level changes presents an immense challenge to any comprehensive inventory of the aquatic biodiversity let alone identification of population structures and genetic diversity within taxa. Given that most of the fish species are endemic, closely related and yet to have formal nomenclature and scientific descriptions written, the task becomes daunting and will require many years to

provide even the basic information for management, i.e. what is there and where is it, let alone the basic biological characteristics and ecological requirements of the multitude of species.

When all these environmental and biological factors are considered, Lake Victoria is clearly a very distinctive system when compared to well studied temperate lakes. The transferable lesson from temperate great lakes is that human activities on the lake and within the catchment can impact even the largest lakes in the world, and science can identify the root causes of undesirable changes and guide management to maintain or restore beneficial uses of great lakes. But without science, informed management and the will of the people of the basin, there is no solution. All are necessary, but science provides the knowledge to empower management and motivate the people. The SAR recognized the need to build the human capacity within the basin, provide the necessary infrastructure to strengthen the culture of Lake Victoria science, and create the cadre of scientists to produce. The SAR recognized that the "project is the first phase of a longer term program", and that it must provide information for longer term management, establish mechanisms for cooperative management and demonstrate remedies "while simultaneously building capacity for ecosystem management." The scientific success of LVEMP phase 1 must be judged as much on the building of the human capacity to enable continuing strong science and scientific management as on the degree to which it has answered questions posed in the SAR. The Lake Victoria ecosystem which includes the people and all their activities in the basin will continue to develop and change and the environmental and scientific challenges of the future will not be the same as those in the SAR. A strong scientific community assures adaptability to changing conditions and makes sustainable development possible.

Perhaps the ultimate challenge to LVEMP is to build a culture of science-based management in one of the world's poorest regions. The scientific capacity of the region and the economic capacity to introduce and maintain management action are ultimately limited by the economic productivity of the region. The negative impacts on the temperate great lakes of North America evolved during a period of rapid regional economic development. When problems had finally reached crisis, there was a public sector tax base to fund the research and to stimulate investments to address the systemic environmental issues. In Lake Victoria, the evolution and recognition of the problems of the lake have occurred while economic development has been disappointing and relatively static. It is sobering to realize the first scientific assessment of the Lake Victoria fishery took place in 1926-1928 (Graham 1928) contemporaneously with first scientific assessment of the Lake Erie (Bogue 2002). Those surveys both arose in response to declining catches in the fishery and sought causations. Since 1928 Lake Erie has "died" and returned to life (Sweeney 1993) after hundreds of scientist-years of study and billions of dollars in investments to improve water quality and fisheries management. Without investments in science and environmental management to reverse or at least stabilize current trends on Lake Victoria, the lake will continue to degrade. The economic wealth that would give some margin for error in current or future management by being able to fund expensive future restoration as in the North American great lakes is not present in the Lake Victoria region. This requires an even higher standard of performance from regional scientists and their international collaborators. Not only must the recommended management actions be as well founded and scientifically defensible as

possible, but they must all be economically achievable. This may be the ultimate challenge and may limit improvement in the lake to economic development and poverty alleviation in the region. Recommended environmental management action must bring definable and immediate social and economic benefit; this is a challenge not necessarily constraining scientists in richer economies and increases the burden of proof on Victoria ecosystem science.

Constraints in stocktaking the science of LVEMP

The scientific method consists of a sequence of steps towards the acquisition of new knowledge and understanding. The first crucial step is the gathering of observations of the system of interest, these lead to testable hypotheses that might explain the phenomenon of interest, then experimental designs to determine the acceptance or rejection of current hypotheses through structured observation with rejection leading to further hypotheses. It is an iterative, not an instantaneous, process. When dealing with natural systems the speed of acquisition of new knowledge is often determined by the generation times of the longest lived organisms in the system of interest. LVEMP was originally designed as a five year program starting in 1996 and has been extended by two years. It is not complete, and all the results of activities under LVEMP first phase are still being analyzed and collated. This stocktaking cannot be a final statement on the scientific outputs of LVEMP, but it can be a snapshot of work completed to a publication stage and a necessarily subjective assessment of work in progress and expected outcomes from that research. In many cases, the institutions and agencies responsible for implementing LVEMP had first to obtain the basic infrastructure to allow them to *begin* to make observations, the first step in the scientific method. In other cases, the previous research of regional and international scientist allowed hypotheses to be tested with those initial observations. Delays in initial implementation of LVEMP especially in procurement of essential equipment resulted in little lake-based research during the first 12-18 months and this led to the need for the extension period. Many of the major scientific outputs from LVEMP necessarily lie in the future. Positive documentable progress on the major issues will be highlighted, but where there is yet little published information it would be misleading to conclude that there has not been progress. The major published outputs considered in this report are the results of the National and especially the Regional Scientific Conferences held in 2001 sponsored by LVEMP. It is assumed that the LVEMP components would bring forward the best of their research to these conferences and that the full range of LVEMP activities would be represented. Where work is still in progress, interviews with LVEMP component scientists and international scientists are the basis for a judgment on the likely impact of the research. In some instances, published Ph.D. theses (supported by LVEMP wholly or in part) are cited. Lastly recent publications in the international scientific literature are cited where they speak to the major issues identified in the SAR for LVEMP.

Lake Victoria Environmental Management Project

LVEMP in all three countries is similarly structured into major components, and scientific research took place primarily within Fisheries Research, Water Quality Management, Water Hyacinth Control, Land Use and Wetland Management although these components had a lesser or greater research content depending on the implementing

country and agency. To discuss the scientific progress of LVEMP reference will be made to the major issues as defined in the SAR (highlighted in italics below when quoted from SAR) with secondary reference to the science-based LVEMP components mentioned above.

Lake Biota and Fisheries

Commercial fishing (selling to structured markets beyond the local village) began in Lake Victoria around the end of the 19th century when the railroad reached the lake and provided access to rapidly growing Nairobi and the coast. Even in the early 20th century concerns were raised about falling catch per unit effort in the fishery leading to the first scientific fisheries assessment on the lake (Graham 1928) which recommended gear limitations. The fishery was static and even in a slow decline in yields at the time the Nile perch and several exotic African tilapiines were introduced in the 1950's. Beginning in the 1980's the catches of perch grew dramatically and now dominate the fishery along with the exotic Nile tilapia and the native *Rastrineobola* (dagaa). A rapid expansion of the fishery followed the increase in perch expanding from yields of 100,000 T to as much as 500,000 T. A vibrant and regionally important export (to regional and global markets) has resulted with fisheries primary and secondary economic activity accounting for approximately 10% of regional GDP. The history of fisheries management for sustained yields is a sorry one internationally and in Africa, and concern for sustainability of the critical fishery resource in Lake Victoria was a primary motivation for the three riparian countries that share the fishery to undertake LVEMP.

Stock Assessment

The need for a stock assessment is listed in the SAR, but it also recognized that the Lake Victoria Fishery Research Project funded by EU and implemented by the three countries would conduct whole lake stock assessment contemporaneously with LVEMP. This study was completed in 2002 and developed a fisheries management strategy for the commercial fishery recently approved by all three countries. It concluded that the current fishery is overexploiting the Nile perch stock and recommends, applying the precautionary principle, that the sustainable yield of the lake is between 250,000 and 300,000 T, well below yields throughout the 1990's. It also recommended a slot size for fish to be accepted for processing at fish factories to reduce the harvesting of immature fish. This study also produced in conjunction with LVEMP estimates of fishing effort through frame surveys and conducted a number of socioeconomic studies on the fishery and the potential for co-management by communities which is also a major thrust of improving fisheries management in LVEMP. The regional and national cruises of LVFRP also produced significant volumes of spatial data on lake stratification, oxygen conditions (and the spatial relation of fish to those conditions), and chlorophyll (indicator of algal biomass) that will complement LVEMP water quality studies.

Fish Biodiversity and Biology

In recognition of the LVFRP and its conduct of the stock assessment fisheries research, LVEMP activities focused on distribution and abundance of the non-commercial species as well as basic biology of the commercial species, e.g. breeding periods and areas, as well as the biodiversity of the aquatic biological communities that

sustain the fisheries and other beneficial uses of the lake. The SAR expected that *"The (LVEMP) program will rectify the serious lack of knowledge about the entire aquatic population of the lake, focusing especially on non-commercial fish of great biological interest, their species composition, population structure, food and feeding habits, trophic relationships, reproduction and breeding habits, recruitment patterns, growth, oxygen tolerance, mortality, and migrations, as well as the other organisms which play key roles in sustaining the Lake Victoria ecosystem, including specifically other aquatic vertebrates (frogs, reptiles, birds and mammals), macroinvertebrates (insects, molluscs, Caridina), microinvertebrates (copepods, cladocerans, rotifers), phytoplankton (diatoms, cyanophytes, green algae), macrophytes, and bacteria."*

There have been extensive biotic surveys in all three countries although they have not been implemented in the same time period or with regular frequency sufficient to evaluate fullyseasonal aspects of biotic abundances. Delays in the initial implementation of LVEMP have resulted in planned surveys of several areas still to be completed even during the last year of the extension of the project. The surveys have not only been conducted on Lake Victoria proper but also in small water bodies and rivers draining (or formerly connected) to the lake. These surveys are also sampling areas of the lake never before accessed on a wide geographic scale including rocky shores, wetlands and the numerous marginal bays. The geographic coverage is exceptional and likely adequate, but the methods of sampling have not been standardized across the region for all these surveys. For example, electrofishing returns more fishes and species on rocky shorelines than passive gears, but electrofishing has not been uniformly applied across the whole lake (Bayona et al. 2001). These surveys have confirmed that several species of fishes formerly abundant in Lake Victoria, and now rare or extirpated in the main lake e.g. *Oreochromis esculentus*, are present in several of these "satellite" lakes and dams (Bayona et al. 2001; Katunzi 2001; Masai et al. 2001; Namulemo 2002; Nagayi and Ogutu-Ohwayo 2001). However, the taxonomic assessment of many of the biotic groups sampled on these surveys, especially the macroinvertebrates, the phytoplankton and the haplochromine fishes, remains hindered by the lack of sufficient adequately trained staff in systematics and taxonomy and suitable taxonomic reference material and museum specimens (for confirmation) within the region. Biotic identifications for these groups are generally not to species level; and where they are, the identifications have not been confirmed by experts with reference to type specimens. Given the size of the lake basin and the high diversity present in many of the groups, the task of fully describing the aquatic species biodiversity still remains let alone examining issues of genetic variability at the population level which may be necessary for conserving critical fish stocks. A critical need here is a haplochromine identification guide for Lake Victoria which can be used for provisional identification of unknown species and systematic archiving of representative specimens for later taxonomic analysis. This will require good museum facilities, training in curation and taxonomy, and multiyear commitment from host institutions and funding agencies to complete this biodiversity assessment. Similar guides and training are required for the algae and macroinvertebrates which are at the base of the food web.

The SAR expected that *"The outcomes of the studies will be species distribution and habitat maps, information on the genetic make up and diversity of different populations, understanding of the causes of decline of fish species, understanding of the*

impact of environmental changes on the biology, behaviour and survival of declining species, guidelines for species conservation and restoration, an updated bibliography of Lake Victoria...". Substantial progress on data acquisition to ensure the outcomes referred to in the SAR continues to be made and will continue into the extension period. But preparation of these final integrative products is just beginning as of July 2003. Training in GIS and the acquisition of base maps for mapping biodiversity at the national and basin scale is underway but full GIS databases to guide management and conservation of aquatic biodiversity is still to be done as it has been done for other African lakes (e.g. Cooley et al 2003).

Genetic characterization has been done on some key endemic species such as *Labeo victorianus* (Maithya et al 2001, FIRRI 2002), *Oreochromis* species (FIRRI 2002), and Nile perch has been examined, and the origin of complex haplochromine flock has received international attention (Verheyen et al. 2003). However, intralacustrine species and stock structure of the numerous haplochromine species remains to be evaluated. Important breeding areas have been identified often in collaboration with fishers' indigenous knowledge (Manyala et al. 2001), and these areas have been gazetted for special seasonal management. Similar gazettement has also taken place in Tanzania and Uganda. This is one example of where LVEMP scientific studies have resulted in establishment of protected areas at least on a seasonal basis.

The causes of decline of species are complex, usually multifactorial and often species specific. Many native species have been reduced to low levels, but the potential for recovery under proper management is evident for some, e.g. *Labeo* (Benno 2003). *Oreochromis esculentus* has clearly been extirpated from the main lake probably through hybridization with the introduced *O. niloticus* (FIRRI 2002), but it is present in numerous water bodies within the basin (Katunzi 2001) as are several of the haplochromine species that were feared lost from the main lake. It is now accepted that the changing water quality conditions can directly impact on haplochromine species diversity (Seehausen et al. 1997) and that certain trophic elements of the haplochromine species flocks e.g. predators and open water detritivores were more susceptible to extirpation by competition and predation than others e.g. rock dwelling insectivores (Witte et al. 2000)

Eutrophication has resulted in several ecosystemic changes especially in regards to oxygen conditions and the algal species at the base of the food web. Seasonal deoxygenation of the deeper waters of the lake certainly forces extensive lateral movements of fishes that can be accommodated better by some species than others. The loss of large diatom taxa and the emergence of cyanobacteria as the dominant primary producers in the lake have changed the food quality for consumers and fishes as well as perhaps increasing exposure to algal toxins. However detailed knowledge of the bioenergetics of the affected and surviving fish species must still be determined to assess the impact these factors could have on declining abundance. Species strongly affected by eutrophication will require a reversal, or at least a stabilization, of eutrophication to recover to former levels of abundance.

The water hyacinth mats that were extensive in the mid 1990's actually led to resurgence of some native fish species indicating their potential for population recovery. Hyacinth mats can provide refugia from fishing pressure as well as Nile perch predation and competition (Njiru et al. 2001). Such mats are not essential for recovery of these species e.g. *Protopterus* and *Clarias*, but they provide relief from population pressures

imposed by fishing and predation. Recovery of stocks to former levels can be achieved if those mortality factors are relieved through appropriate and successful fisheries management.

Two regional books are planned to capture the results of the extensive surveys and the studies on factors affecting biodiversity and fisheries production. *The Biodiversity of Lake Victoria* and the *The Biology and Ecology of Lake Victoria Fishes* will be major outputs published by the national fisheries research institutes before the end of the extension period. Uganda has already completed "Technical Guidelines for the Management of Fisheries Resources, Biodiversity and Environment of Victoria Basin Lakes" that summarizes available technical information to provide the basis for formulation of policy and regulations. Still to be completed but very desirable would be a similar publication representing regional consensus with recommended objectives and actions for managing the natural resources of the basin in a manner consistent with the sustainability of the aquatic resources of the lake. A similar regional integration remains to be done in regards to the bibliography of Lake Victoria publications. Individual bibliographies have been completed by each fisheries research institute.

Aquaculture

The SAR envisioned that, as part of the fisheries research *"The program* (Aquaculture subcomponent)) *will study the domestication of indigenous species of high nutritional value. ...The outcomes of the program will be restored populations of selected endangered and threatened species (particularly Oreochromis esculentus, Oreochromnis variabilis, Labeo victorianus, Bagrus docmac, and Protopterus aethiopicus), improved fish supply to local riparian communities, return of delicacies to consumer markets, and development of commercial activity in ornamental species which will secure their survival rather than threatening it as at present."* In retrospect, the objectives of this program, though laudable, were too ambitious. Much basic work had to be done to establish aquaculture as an economic activity within the region and to strengthen the capacity of the fisheries institutions to develop, maintain and disseminate new taxa. In addition the educational and extension services required to maintain self-sustaining economically viable aquaculture on the farm or at larger commercial scales had to be developed.

Therefore the challenge for the aquaculture subcomponents was two fold—build an economic activity and bringing into culture new species native to Lake Victoria. Progress has been good on both aspects especially in Uganda where bilateral assistance from DFID has stimulated progress and Kenya which already had reasonable levels in investment in aquaculture. Scientific progress was made through bringing *Clarias gariepinus*, *Labeo victorianus* (Owori-Wadunde 2001)and *Oreochromis esculentus* and *O. variabilis* (Shoko et al. 2001) into culture and defining the potential for aquaculture in the basin. *Labeo* and *O. variabilis* are now moving into farm trials. *Clarias* is already popular in farm-based systems that have potential to supply bait for the rapidly growig long line Nile perch fishery as well as for domestic consumption. The prospects for development of aquaculture in the Victoria basin and technical progress towards realizing those prospects will be the subject of a regional book on *Aquaculture in the Lake Victoria Basin* that will be published by the three national research institutes before the end of the first phase of LVEMP. The regional aquaculture programs remain focussed on

aquaculture as a source of protein for human diets at a local scale. The potential for large scale commercial aquaculture to relieve fishing pressure on the lake is still untested as is the possibility of culturing ornamental fishes for the export market for colourful haplochromines as was suggested in the SAR.

Socio-economics and Database

In the SAR, the national fisheries research institutes were to conducted socio-economic studies to advise on development policies for the rapidly burgeoning fishing villages and communities. They were also to establish national databases to define baseline conditions for the fish industry and fishing communities against which the efficacy of development policies could be evaluated over time. *"The program will further provide information on current fishery distribution patterns, community involvement in harvesting up to marketing of fish, how activities of fisher folk contribute to environmental degradation, nutrition, health and other social amenities of lakeside communities, alternative management systems incorporating different stakeholders, the contribution of fisheries to the three national economies, and the consequences of changes in fishing policies."* During implementation it was recognized that several of these LVEMP objectives were shared by the LVFRP that also had a socio-economic and database component. The programmes of the two projects were harmonized by the national research institutes. There is now a wealth of information in all three countries on the contribution of the fishery to the national economies (e.g. Kulundiwa 2001), and to enlighten debates on the possible negative consequences of fish export on local nutrition (Jansen 1997; Onyango 2001), as well as evaluations of environmental, health and social status of fishing communities and their capacity for co-management (Geheb 2002). A concise overview of the socio-economic issues in fishing communities in Uganda and their implications for policy is available in FIRRI (2002).

A common fisheries database SAMAKI developed by the LVFRP has been adopted by all three countries and the Lake Victoria Fisheries Organization for fisheries statistics. The capacity of this database to incorporate socio-economic data has not been tested yet and the level of training in database maintenance and design needs to be improved before the end of the LVEMP extension period. Much valuable data now is not securely stored in accessible and stable databases. These data are the baseline against which progress during LVEMP phase 2 will be evaluated, and preparation of LVEMP phase 2 should insure that these databases are available in secure, stable and accessible formats.

Water Hyacinth

The SAR did not specifically identify a scientific research aspect to the Water Hyacinth components as it focussed on reduction and control. *"The control program will rely on mechanical methods and limited chemical interventions for rapid short term control in restricted areas, and biological agents for longer term control. Reducing nutrient inflows into the lake will be a vital element in long term approaches to dealing with the problem. The biological control program will rely initially on multiplication and release of two weevil species that have been used and found effective world-wide, and have already been imported, reared and released in Kenya and Uganda.* It is noteworthy that, in this case of control of a specific nuisance water weed, LVEMP did

benefit from previous international scientific research which demonstrated the efficacy of biological control and defined effective operational procedures. Certainly, the scientific research completed and ongoing under LVEMP will, in the same way, serve in preventing and controlling undesirable changes in other large tropical lakes due to species invasions and eutrophication. The biological control program instituted by LVEMP was spectacularly successful with reductions of at least 80% from periods of maximum coverage in the mid-1990's. The reductions have also been sustained (e.g. Aloyce et al. 2001). Relevant research has been done within Water Hyacinth components in all three countries to evaluate economic impacts of hyacinth (Wawire and Ochiel 2001) as well as quantitative monitoring of hyacinth and weevil abundances (Ochiel and Njoka 2001; Ndurunguru et al. 2001) effects on fisheries of large mats (Njiru et al. 2001), ecological impacts of the mass die-off and sinking of hyacinth in 1998 (Twongo et al 2001), and the potential for complementary biocontrol using native mycopathogens (Molo and Ogwang 2001). The recognition in the SAR that reducing nutrient inflows would be a vital element in the long term has resulted in research being conducted especially in Uganda on which nutrients and what concentrations restrict hyacinth growth so that effluent guidelines can be formulated to insure poor growth of hyacinth.

Eutrophication

As the second largest freshwater lake in the world by area and the largest tropical great lake, the sheer size of the lake challenges adequate characterization of water quality throughout its expanse, but especially along its complex shoreline, let alone identifying changes in water quality over time. In addition water is highly mobile, not only in the sense of the movement through the hydrologic cycle, but also within the lake as winds and density changes due to temperature changes set water in motion horizontally and vertically. These water movements can provide local services by diluting and reducing concentrations of point source pollutants, but they can also carry pollutants over long distances and cause negative effects far from their origin. Most aquatic organisms are microscopic and have very short life spans and high maximum growth rates (especially at tropical temperatures) leading to rapid changes (daily to weekly) with complex population dynamics and species interactions. In view of these complexities, the SAR gave very necessary but challenging objectives for water quality studies:

"The program will provide details of limnological changes, model and predict their short and long term consequences, and provide guidelines for ameliorating potentially disastrous changes. The program will provide quantitative information on nutrient loading and recycling in the lake (particularly the internal loading of sediment phosphorus); sources and mechanics of eutrophication and pollution and their effect on lake productivity (with a particular focus on ways to stabilize or reduce eutrophic status); phytoplankton communities and their composition; algal blooms and their dynamics; lake zooplankton, microbes, benthic flora and fauna, lake fly and their roles; primary production including estimation of lake carrying capacity; stratification of the lake and the increasing problem of anoxia; trophic inter-relationships; and lake palaeolimnology."

The capacities of the implementing agencies in the three countries were very limited at the beginning of LVEMP. In the decade prior to LVEMP most of the water

quality data on the lake came from special studies undertaken by the fisheries research institutes as part of their fisheries assessment programs. These studies were central to raising the concerns about the changes in the lake (e.g. Ochumba and Kibaara 1989; Hecky 1993; Hecky et al 1994), but these special studies were spatially restricted on such a large lake and not always regular in the timing of their sampling to ensure catching extreme events or to characterize adequately even "average" conditions. Two of the countries did not have functioning lakeside central laboratory structures, let alone analytical equipment or sufficient trained staff for conducting highly technical analyses or field measurements. Uganda was in the best situation because of previous and ongoing bilateral assistance from DANIDA for development of a national laboratory and capacity for water quality assessment (focussed inland on rivers and boreholes); but, even there, regular routine sampling of the lake was not possible. None of the Water Quality components had their own vessels or water craft nor experience in their operation. Vessels that were available were heavily subscribed to other purposes and these logistical issues hampered progress in the first years of LVEMP. In the SAR little mention was made of the need for studies on the lake's water balance. This was due to the ongoing JICA/FAO Lake Victoria Water Resource Assessment Project (WRAP) that was installing hydrological and meteorological equipment on the major rivers and offshore islands to permit monitoring of major water fluxes to and from the lake. The WRAP was re-establishing a hydrometeorological monitoring network that had fallen into disuse and decay after 1977 due to civil wars in Uganda and declining conditions in public service programs in the other countries. By the early 1990's there was essentially no monitoring program even for basic information such as river discharges. The FAO project ended prematurely in 1998, and arrangements were made so that LVEMP would finish installation and take over operation. This was required because good measurements of water fluxes in and out of the lake are essential to calculating pollution loads and modeling lake hydrodynamics. Consequently water quantity studies are an important part of LVEMP scientific investigations and provide the foundation for all other water quality studies.

Water Quantity

Okonga (2001) reports on the first two years of the LVEMP hydrometeorological program and demonstrates that measured inflows and outflows (evaporation calculated from meteorological data) balance reasonably well with the error between budgeted and observed changes in lake level agreeing within an error of 13%. This gives confidence that the monitoring network and the apportionment of the fluxes measured at individual stations over the lake is reasonably accurate and provide a confident basis for calculating loads of pollutants based on river flows and precipitation. Sangale et al (2001) compare rainfall-runoff relationships for three major Kenya rivers as measured during 1950-1960 and during 1990-2000 and show that average daily discharges for these rivers have increased by 10-30%. They conclude that soil degradation and loss of vegetation cover due to land clearance and increased pasturage has reduced water infiltration and increased runoff. Experimental studies (Majaliwa et al. 2001) confirm the likelihood of this change in runoff. The persistently high lake levels through the latter part of the last century until now compared with the first half of the 20th century may reflect both wetter climate (Yin and Nicholson 2000) as well as increased runoff coefficients. The determination of the

	5. 1500 Impact of fishing gears translated in to local language (Luganda) 6. 200 stakeholders visited FIRRI looking for L. Victoria related literature 7. Request for 500 copies of books on water hyacinth resurgence got 8. Arrangement to print more copies of technical guidelines on Lake Victoria book have been finalised 9. School have continued to visit FIRRI to look at the Aquarium, museum and learn more about learn Victoria 10. 4 News paper supplements published 11. 2000 fact sheets published	80%	
4 .Set up electronic communication networks and a modular telephone system that will allow local and international teleconferencing.	Real time achieved. Wireless internet access maintained.	70%	Needs constant maintenance. Installation of communication (modular telephone system) is yet to be procured
5. Establish a Local Area Network (LAN), email, internet access and on-line publication	1. A Local Area Network (LAN) established to 70% capacity.	70%	There is need to complete and upgrade the LAN
6.Compile and disseminate information on Lake Victoria on CD-ROM. Acquire Electronic data bases Make CD-ROMS	Three data bases accessed from FIRRI. 4 CD-ROMS on Library holdings and selected texts	80%	
7.Set up desktop publication capabilities. Procure equipment and set up GIS facility.	1. One secretary trained in desktop publishing	60%	Need for training all scientists in GIS applications
8.Rehabilitate and expand library infrastructure to provide more space and transform the infrastructure into a data centre,	1. Library shelf space increased 2. Fumigation of library and component assets undertaken	5%	Space limitation to be addressed. Related to Civil works A continuous process
10. Procure and up-date relevant journals/periodicals (from 1995 to present) and stocking the library with books,	Electronic database CD ROMS	50%	Awaiting LVEMP Secretariat approval

11. Improving human resource capacity to operate a fully functional Fisheries Data Centre by training library and database staff,	1. Short course in Computer applications undertaken by marine technician 2. Hired staff recruited and some essential posts (Component Finance Assistant filled 3. Training/dissemination Officer) identified at sub-component level	5%	More short courses in database needed for the diverse component needs including database management, GIS, web-design, etc Other urgent component positions should be approved (Information assistant and Component secretary and maintained.
12.Strengthening Data and Information networks with regional research centres and projects	Completed assignments of Regional Taskforce and Steering Team formed to oversee regional Database development	30%	A Consultancy yet to be agreed by the three Secretariats awaited and recommendations to be implemented

relative importance of these factors on maintaining water levels is necessary in order to plan land use without effecting unexpected and unwarranted affects on downstream water uses including hydroelectric potential and discharge to the Nile at Owen Falls dam.

Eutrophication, in-lake monitoring, and pollution loading

LVEMP has set up the first comprehensive water quality monitoring program for a great lake in Africa and one of the most comprehensive programs operating on any great lake today. This was done through regional collaboration in the design and in recognition that the size of the lake required extensive spatial coverage as well as more detailed attention to inshore and urban areas (Rutagemwa 2001). The operation of the network has covered nearly two years in Tanzania and a somewhat shorter period of full coverage in Uganda. The Kenya portion of the network has been set back by funding issues but one continuous full year of sampling will be accomplished in the extension period of LVEMP. The database of water quality created during the initial phase of LVEMP will provide the baseline that will allow the establishment of trends during LVEMP phase 2 and to evaluate whether management actions to improve water quality are having effect. The longest continuous data sets for water quality on the lake (starting in 1989) were initiated by FIRRI and continued by the Eutrophication subcomponent in Napoleon Gulf and Bugaia Island in Uganda. There are comparable data available for these stations from 1960-61 (Talling 1966) and these provide the best data set for long term trend analysis and must be a priority for continuation into the future. The water quality results have generally confirmed earlier results (Mugidde 1993; Hecky 1993) that the lake is spatially variable with higher algal biomasses and reduced transparency in inshore areas compared to offshore areas. The LVEMP network extends farther offshore and demonstrates that the variability in current water quality parameters is even greater than previously appreciated and much greater than in the 1960's (Talling 1966). The monitoring network will now be able to document the extent of these different areas and differences in dynamics of the physical, chemical and biological properties both across the surface of the lake but also with depth.

Mugidde (2001) has demonstrated that the nitrogen fixing cyanobacteria which now dominate the lake's phytoplankton (Kling et al 2001; Lyimo and Sekadende 2001) account for 70% of the nitrogen input to the lake. This result is especially significant as it clearly shows that nitrogen loading cannot be reduced directly because it is of biological origin. Mugidde et al (2003) conclude that reducing P inputs to the lake will be necessary to reduce algal biomass and reverse the unwanted effects of eutrophication. Tamatamah (2002) has measured atmospheric deposition of total phosphorus (TP) directly on the lake may account for over 50% of the TP loading. There is uncertainty in these estimates because all the measuring sites are land based as yet; there is need to extend these measurements on to the offshore islands to improve lakewide estimates of atmospheric loading. All three countries are now measuring atmospheric deposition both as wetfall and dryfall at several stations so regional patterns may yet appear; but Tamatamah found very similar deposition rates around Lake Victoria as well as in comparison to Lake Malawi and other tropical measuring sites. The atmosphere appears to be the most important single source of TP loading to the lake. Industrial atmospheric sources are minimal in the Victoria basin. This phosphorus originates from the land surface of southern Africa and restoring vegetation cover, reducing biomass burning, and

increasing soil moisture will be necessary to reduce the atmospheric loading of TP to Lake Victoria.

Early results of the Kenya water quality monitoring program also offer important insights to the processes eutrophying Lake Victoria. Njuru (2001) found that water quality conditions within Winam Gulf were very different than outside the Gulf in Lake Victoria proper. Concentrations of total suspended sediments, total nitrogen, nitrate, total P and dissolved silicon (an essential nutrient for the diatom algal group) were all higher in the gulf. Despite the presence of the major city of Kisumu discharging untreated sewage into the lake and several other urban centres on the shores of the Gulf and several substantial inflowing rivers from areas with intensive agriculture, the gulf still has lower concentrations of soluble reactive phosphate than the open lake. The shallow gulf is maintained in a well-oxygenated condition throughout the year and that keeps phosphate strongly bound to mineral particles that are frequently resuspended by wind mixing. As the mineral bound P is carried to the open lake and settles into anoxic deep water, soluble reactive phosphate is released. Phosphorus transformations in Lake Victoria proper and denitrification in low oxygen conditions create low nitrogen to phosphorus ratios that favour the growth of N-fixing cyanobacteria in the open lake (Njuru 2001, Kling et al. 2001). The shallow depths of the Gulf favour resuspension of materials and higher turbidities and reduced light transparency. Light limitation of the algal populations in the gulf may constrain algal growth rates and reduces demand on silicon, nitrate and soluble reactive phosphate within the gulf. The gulf does provide a net source of TP to Lake Victoria proper, but it does retain a substantial proportion of TP from incoming rivers and municipal drainages. For example the concentrations of TP within the gulf average under 0.3 mg/l (Njuru 2001) while the Nyando River which has the highest mean concentrations of inflowing rivers, mean 0.5 mg/L (Okungu and Opango 2001) . Kisumu Bay which receives urban drainage of Kisumu Town has mean TP of over 0.5 mg/L but this is diluted within the Bay by rivers of lower concentrations and sedimentation within the bay. However, the relative importance of dilution and sedimentation requires a full nutrient budget for the bay and a complete annual dataset. An outstanding issue still under study during the extension is a detailed hydrodynamic study of water exchange through Rusinga Channel. Because of the episodic nature of this exchange, sophisticated current monitoring equipment must be deployed in situ to make frequent measurements of currents over the depth of the channel over prolonged periods of time in different seasons and wind regimes. Such studies are required before the significance of loading from the Winam Gulf to Lake Victoria proper can be evaluated. Delays in the implementation in Kenya have retarded the completion of this study which has high regional significance and will be necessary for directing investments in remediation to reduce nutrient loadings to improve water quality both in the Gulf and in the Lake proper.

Sedimentation and Hydraulic Conditions

The SAR recognized that much improved knowledge on sedimentation and lake circulation would be necessary to complete accounting for nutrient and sediment inputs and their distribution through out the lake. At the time of the initiation of LVEMP (1996) there was sufficient information to direct sedimentation studies to the deltas and areas of

plume influences for rivers that were expected to be major sources of sediment loading from the watershed:

"The pilot sedimentation study will estimate sedimentation rates at the mouths of three rivers, the Kagera (Uganda), Simiyu (Tanzania) and Nyando (Kenya). It will assess the rate of release of nutrients from sediments, analyze sediment-biota associations, and compare the data with soil losses from surrounding areas."

The major cities on the lake were all located on major embayments which have topographically restricted circulation with the lake through relatively defined channels. Concern about the local impacts of effluents from these urban areas focussed attention on water exchange through these channels to determine the impact of retention or dispersion of nutrients and contaminants both locally near the urban areas and within the gulfs and bays on which they were located as well their potential impact of Lake Victoria proper:

"The pilot hydraulic study will measure patterns of water circulation in the Rusinga Channel (Kenya), and in similar areas in Tanzanian and Uganda waters, (Mwanza Bay and Murchison/Pilkington Bays respectively) to determine the interaction between vertical and horizontal circulation components, improve existing estimates of hydraulic retention periods in the lake, and develop simulation models of the dynamics of nutrients and phytoplankton which will be used to predict the impacts of eutrophication control programs and pollution intervention strategies."

However, concern about water circulation extends beyond the channels and embayments as large scale water movements within the lake proper will effect algal growth and dependent secondary production, patterns of sedimentation of nutrients and contaminants, and contaminant concentrations in fish and biota, fish larval dispersion from breeding areas and movement of nuisance floating weeds such as water hyacinth. This large scale circulation was addressed within LVEMP by a contribution from the Dutch Trust through the World Bank that enabled the installation of a coupled three dimensional hydrodynamic and water quality model that would have the capacity to predict dispersion of nutrients and contaminants, dependent oxygen conditions, etc. if appropriate and adequate hydrometeorlogical input data were available. The model has been installed and has had initial calibration with some historical data. However, application requires verification with data now being collected by the three countries and further training on these applications to insure that local scientists and technicians can use the model for analysis of present conditions as well as forecasting future conditions under LVEMP 2 efforts to modify undesirable water quality aspects of the lake. The data acquisition by all three countries for necessary verification and training will not be completed until near the end of the current extension period in all three countries, i.e. December 2005 for Kenya.

In all three countries, progress on field studies of in-lake sedimentation and hydraulic conditions have been delayed in implementation. Sediment and TP loadings have been determined for the Kagera, Simuyu and Nyando Rivers (Machiwa 2001; Tamatamah 2001; Okungu and Opando 2001). The Kagera is the largest single river flowing into Lake Victoria accounting for 44% of the long term average total riverine inflow to the lake. Initial results indicate that these two smaller rivers are disproportionately important as sources of sediment and TP because of the much higher concentrations of these materials transported in their lesser discharges. Land disturbance, especially loss of forests and natural vegetation cover, and intensity of agriculture in the

riparian lake districts is proportionally much greater in these smaller catchments. The proportion of intact forest in the lower reaches of the Kagera and the presence of extensive floodplain wetlands appears to have kept the quality of the Kagera relatively good although it has been and continues to be a significant source or river-borne water hyacinth into the lake. Sedimentation studies have been completed off the mouth of the Simuyu to determine rates of infilling but detailed studies have yet to be completed at the mouths of the Kagera and the Nyando as called for by the SAR but completion of these studies is planned within the extension period of LVEMP phase 1. In-lake sedimentation rates are now routinely being estimated using sediment traps in short-term deployments as part of the in –lake monitoring program and these have demonstrated that sedimentation rates are highest at littoral stations where chlorophyll and suspended carbon, nitrogen and phosphorus concentrations are also highest. The proportion of this sedimenting material which is regenerated prior to permanent burial is yet to be determined, but will be such estimates will be necessary to estimate the role of internal nutrient supply in maintaining high concentrations in surface waters and continuing eutrophication.

Hydraulic conditions are yet to be determined in the channels isolating the bays on which the major cities in the catchment are located. In the lake proper Uganda has initiated a program of thermistor chains and current profilers monitoring thermal structure as well as deep water and surface currents that will provided the first high resolution measurements that are essential for validating the hydrodynamic-water quality model. This technology is also appropriate for evaluating water exchange between the bays and the main lake. MacIntyre et al (2002) have recently demonstrated how these water movements in and out of embayments are subject to not only local forcing by winds and temperature change but also respond to large scale changes in the larger lake. Although staff are being trained in data acquisition and running the computer models, the complexity of hydrodynamics in this equatorial lake will require a high level of expertise in physical limnology that does not yet exist in the agencies responsible for the monitoring and modeling. Further training to Ph.D. level will be necessary in LVEMP phase 2 if the management potential of the application of the model will be realized.

Water Pollution

SAR concerns about water pollution recognized the threat posed to the lake by excessive nutrient loading, the growing potential for agrochemicals especially pesticides and herbicides to contaminate or intoxicate food webs including fish and the concern about risks emanating from industrial processing within the urban areas and the basin in general:

"The overall aim of the program is to improve management of industrial and municipal effluent, and assess the contribution of urban runoff to lake pollution in order to design alleviation measures. The program will prepare inventories and classifications for all factories and industries in the catchment, assess treatment of effluent before discharge and its dilution and dispersion levels in the receiving water bodies, quantify pollution and nutrient flows from urban runoff, identify and characterise pollution "hot spots", ... and initiate pilot treatment projects in selected municipalities and industries."

The potential of urban areas to negatively impact water quality is clear in studies on the Mirongo River which serves as a storm water drain through Mwanza (Mnyanga and

Semili 2001). Passage through the town elevates nutrients (by a factor of 10-20) and fecal bacteria by three orders of magnitude due to the diversion or raw sewage into the river near its exit to the lake necessitated by a dysfunctional sewage treatment plant. There are unacceptable local risk created by this situation. The industries and human activities of Mwanza town do cause a measurable enrichment of some metals in sediments near the town and the concentrations decrease with distance from the town. A study of metals in *Oreochromis niloticus* found that concentrations were low in fishes in Mwanza Gulf (Kishe and Machiwa 2001). In this herbivorous fish there was no evidence of bioaccumulation with increasing size and the fish were all below FAO guidelines for consumption. Campbell et al (2003) found similar results for Mwanza Gulf and in fact for all of the major embayments near cities in the lake in regards to Hg which is the most toxic metal to be found in fish flesh.. Risk of Hg intoxification from eating even predatory species such as Nile perch are extremely low in Lake Victoria at present despite concerns about Hg contamination arising from use of metallic Hg in gold mining in the Tanzanian catchment (Campbell et al. 2003).

Studies on the quality of urban runoff have been completed in all three countries documenting in GIS database all significant industrial and urban sewer outfalls. This database provides the basis for investments to improve the effluent quality and reduce health risks. A hydrodynamic model has been installed at National Water and Sewage Corporation in Uganda for Murchison Bay where most of the industiral effluents, urban drainage and output of the Bugolobi sewage plant (after secondary treatment) enter Lake Victoria. The model predicts dispersion of these effluents in Murchison Bay The city of Kampala also takes its drinking water from the channel of the bay leading to Lake Victoria. Simulations have shown that under realistic scenarios for growth of the urban population that the cost of treating water for drinking will rise rapidly over the next decade, and there is realistic possibility that the water may become untreatable in time unless more investment is made in increased sewerage and urban waste management.

The potential of constructed or managed natural wetlands to improve industrial, urban and agriculture effluents was recognized in the SAR:

The pilot industrial effluent treatment will create "wetlands" to test tertiary treatment through filtration of industrial waste from the PanPaper Mill in Webuye (Kenya) before it discharges into the Nzoia River, from various industries in Mwanza town (Tanzania), and from various industries in Jinja (Uganda). The pilot municipal effluent treatment will create "wetlands" to test tertiary treatment through filtration of municipal waste in Kisumu (Kenya), Mwanza (Tanzania), and Jinja (Uganda).

Tanzania LVEMP has installed and calibrated a wetland model that predicts the capacity of a wetland of known biophysical characteristics to predict the chemical removal or transformation of inflowing materials. This is a potentially powerful tool for demonstrating the economic and service benefits provided by wetlands throughout the basin because all three countries have completed wetland inventories. Uganda has made the most progress in studying the efficacy of the managed and natural wetlands to improve water quality of inflows. Kansiime and Mwesigye (2001) have investigated tertiary treatment effectiveness of wetlands at pilot and now operational scale. Wetlands with interflow through plant communities can accomplish significant reductions in inorganic nitrogen compounds and fecal coliforms and will certainly improve water quality especially when the wetland vegetational growth is harvested for use. Busulwa et

al (2001) found consistent reduction of total nitrogen (50%) and total P (10%) in an urban wetland but found that rural natural wetlands actually released TP and nitrates especially during periods of high flow and floods emphasizing the critical role of interflow through the plant mat as opposed to overflow and channelization that reduce a wetlands capacity to remove nutrients. The area of a wetland relative to the upland catchment and the intensity and seasonality of discharge and water level changes in the wetland are all factors which can affect the wetlands ability to retain, store or release nutrients. To use wetlands in tertiary treatment control of the water flow path through the wetland is necessary. Integration of these results from various types of wetlands and validation of the wetland model from Tanzania will be necessary to evaluate fully the role that wetlands can and do play in determining the water quality Lake Victoria. Completion of similar studies in Kenya during the extension will complement results already available from the other two countries.

Land use

Agriculture is the dominant economic activity in all three countries and ranges from subsistence farming to large scale plantations raising sugar, tea, coffee, flowers etc. The SAR recognized the potential of agriculture activities to impact water quality in the lake through increased sediment and nutrients yields arising from soil erosion, increased use of fertilizers and other agrochemicals to boost productivity:
"It will carry out inventories of agro-chemicals in the pilot areas, conduct field trials on the fate of pesticides and nutrients applied on farms, monitor residues leaching out of the pilot catchments, and pesticide levels in receiving rivers... The soil conservation pilot(s) *will ...quantify soil erosion and nutrient loss from different land covers and uses,..."*
Majaliwa et al (2001) demonstrated through soil erosion studies how different crop covers affect runoff, sediment yield and nutrient loss. In western Uganda open (common property) rangelands had the highest runoff while crops with continuous vegetation cover (banana) were low. Soil erosion losses were highest for annual crops and lowest for coffee and banana. Nutrient (TP) losses were lowest for mulched banana crops. At the basin scale, Okongu and Opanda 2001) agricultural land use increases yields of TP and sediments from Kenya catchments. This detailed information on the impact of agricultural practice and land use can be scaled up to basin scale through soil erosion mapping (Yanda et al 2001) to pinpoint areas needing careful soil management and through modeling to predict yields at a catchment scale. Tamatamah (2002) used the Agricultural Non-Point Source Model to predict the concentrations of TP and sediment transport in the Kagera and Simuyu rivers and found excellent correlation between predicted and measured concentrations. He also demonstrated how strategic restoration of vegetation cover could lead to substantial improvements in river water quality. Evaluation of practical and achievable soil conservaton practices in all three countries have demonstrated that substantial reductions can be achieved in soil erosion and associated nutrient yields from agricultural lands while achieving increased soil moisture and retention.

Current monitoring programs that are establishing the first measured loads of nutrients and pollutants from agricultural watersheds, urban watersheds, and the atmosphere are substantiating in general proportions the role of the these sources previously estimated from general global relationships (Scheren 2001) used to estimate

unmeasured inputs. Current estimates from the Tanzanian sector, estimates that atmospheric deposition accounts for 75% of P loading to the lake while municipal and industrial sources account for 6% (LVEMP Tanzania 2003). Non-point atmospheric inputs of P (Tamatamah 2002) and biological fixation of N (Mugidde et al 2003) dominate the inputs of these nutrient to Lake Victoria on a whole lake basis. In the gulfs and embayments where the major cities are located, urban sources create highl nutrient conditions, but these local sources are less important to lakewide nutrient budgets accounting for <10% total inputs of N and P. P concentrations are currently in excess of algal demand that is primarily limited by the availability of light (Mugidde 1993; Hecky 1993 and Mugidde et al 2003). The light limitation is a result of self-shading by algal biomass within Lake Victoria proper (Mugidde 1993) or higher mineral turbidities in Winam Gulf (Njuru 2001).

In order to reduce algal biomasses and the dominance by cyanobacteria, phosphorus loading to the system must be reduced to lower N:P ratios and the competitive advantage of nitrogen fixing cyanobacteria. Because algal photosynthesis and nitrogen fixation is light limited, the reduction in nutrient loading would not reduce energy flow supporting secondary and fish production; but it would favour a return to diatom algal communities that do not pose a risk from algal toxins and which may be more efficiently used by aquatic food webs leading to fish production. LVEMP by the end of its extension period will have acquired the required data and information to set water quality objectives to be agreed to by the three riparian states. However, the setting of those objectives may be among the first steps to be taken in LVEMP 2. Setting realistic and achievable objectives will then require remedial action plans to achieve those objectives and a projected time frame for accomplishment. Based on current understanding and measurements of nutrient loading, reduction in P loading will be necessary, and this will be accomplished through reduction in soil losses and the associated P, regional initiatives to reduce biomass burning and through reduction in urban runoff and improved sewage treatment.

Pesticide use is increasing in the region in efforts to reduce losses to pest damage and enhance agricultural production in addition for use in control insect vectored diseases. Of particular concern are the persistent and bioaccumulative organochlorine compounds originally in widespread use in temperate countries but now banned there. Most of these compounds were banned in 1986 in Kenya and came under restriction in Uganda between 1993 and 1999. More recently in 2000, international agreement was achieved in Durban on phasing out these persistent organic pollutants (POP's). Despite these national and international restrictions, LVEMP funded studies of atmospheric concentrations in Uganda (Wejjuli et al 2001) and riverine transport and soil (Getenga et al. MS) in Kenya have demonstrated the widespread presence of these compounds in air and rain samples, soils and rivers. This widespread occurrence suggests current use and it is uncertain because of the brevity of the monitoring record whether concentrations are rising or declining. Nor is it certain whether such compounds are necessarily in widespread use locally or are atmospherically transported to the region from more distant regional sources. For example DDT concentrations in the atmosphere in Uganda are higher than measured in Malawi but lower than measured in the Brazzaville Congo (Wejjuli et al 2001). These compounds have been detected in Lake Victoria sediments but deposition rates there are still low though apparently increasing (Lipiatou et al. 1996).

Fortunately the warm tropical temperatures causes high volatilization rates after application and perhaps rapid microbial degradation in warm lake waters. An incident of fish poisoning using endosulfan which is highly toxic to fish led to the closure of the Lake Victoria fishery for an extended period of time with severe economic consequences. Foreign markets required extensive testing of Lake Victoria fish for contaminant burdens before reopening when it was evident that contamination of fish by these POPs was very low in Lake Victoria. Still the risk of increasing use of pesticides within the region calls for careful regulation in order to avoid contaminant levels which have resulted in fish consumption advisories in developed countries. Continued monitoring during LVEMP phase 2 will be necessary to establish time trends and expansion of the monitoring network within the region would be necessary to determine if sources of these POPs are local or regional in use.

The Role of Science in LVEMP Phase 2

LVEMP phase 1 has made good progress on its core activities of providing infrastructure and building human capacity for monitoring and managing Lake Victoria basin resources for maximizing their benefits to the riparian people while conserving the the biodiversity and genetic resources of the lake for future generations and the global community. Over 250 graduate theses, studying the lake and its environment have been supported directly (support for academic fees and university costs) or indirectly through support for field research. Monitoring networks and support laboratories and facilities have been established for water quality and pollution loading, databases of point sources effluents created, use and environmental risk to the lake from agrochemical use defined, and the baseline condition of biodiversity is partially defined. In 1994 prior to LVEMP many if not a majority of the scientific publications about Lake Victoria were authored by international researchers and/or supported by international granting agencies. In this overview, the outputs of regional scientists are evident and the published output of regional scientists is now dominant due to investments from LVEMP. The scientific activities of LVEMP have addressed, if not completely answered, nearly all the challenges identified in the SAR. Discoveries have been made, e.g. the occurrence in satellite water bodies of several of the threatened or extirpated native species from Lake Victoria, the dominance of atmospheric exchange processes in the contribution of nutrients to the lake, the continued presence of POP's circulating in the regional environment etc, and technical breakthroughs accomplished, e.g. establishment of some high valued native species into aquaculture maintenance, the success of biological control in reducing the water hyacinth abundance to an acceptable level among others. However, other tasks initiated in phase 1 still require completion and new discoveries will require new approaches to environmental management in phase 2.

A major task initiated but still requiring completion in phase 2 is the systematic cataloguing of the collections of the biodiversity surveys. In particular, difficult taxonomic groups such as the haplochromine fishes, macroinvertebrates and algae are not yet identified to the species level. Further training in taxonomy, archiving and collection maintenance will be necessary before it can be said that we know the biodiversity of Lake Victoria. Taxonomic guides for these groups and museum collections are necessary in order to establish the baseline condition and to allow monitoring surveys in the future to

determine any positive or negative trends as a result of LVEMP management actions. Because of the high diversity of the fauna, these taxonomic studies to establish the baseline will necessarily continue within LVEMP 2 as well as selective monitoring of biodiversity hotspots as an indicator of successful management. Identification to species level should be complemented with genetic studies to determine population distributions an interactions with the lake. A few such studies on high profile commercial species have been undertaken, but they should be extended to other groups such as the haplochromines where the diversity of the group has suffered. There are outstaniding issues about the size and connectivity of populations that must be answered in order to insure their survival or to plan protected areas if they are needed.

In water quality, there is now a much better appreciation of the spatial variability in critical parameters such as chlorophyll (algal biomass), transparency (related to biomass) and silicon (to support diatom growth) while other parameters such as total phosphorus are rather uniform in the main lake but higher in the marginal bays. The dominance of the cyanobacteria throughout the lake and through much of the year is now established. With this knowledge in hand there is a need for the countries to set water quality objectives for the lake, recognizing the Lake Victoria vision exercise recently completed and water management policies within each country. Setting these objectives in a broad sense should ensure the drinkability and the fishability of the lake while ensuring that water-borne contact vectored diseases are eliminated. One area of research not yet adequately addressed is the relation between algal production and fish production. Major benefits may come to both water quality and fisheries from nutrient reduction because nutrients are now in excess of algal demand and the nutrient conditions favor nuisance and potentially toxic blooms of cyanobacteria which are not efficiently used by all consumers in the food web. The excess production of these poor quality algae aggravates oxygen conditions and leads to seasonal anoxia. However, this remains theory until the benefits of nutrient control for the fishery are made clear through establishing the trophic relationships and the food web models that increase or maintain fish production while reducing noxious algal abundance and excess detritus production.

Once water quality objectives are set, then strategic plans must be put in place to meet those objectives. Nutrient management will be required to even hold the lake in its present condition as regional populations continue to grow and economic activity increases even more. The recognition that the atmosphere is the major transport pathway of phosphorus and nitrogen (by biological fixation) followed by non-point source inputs from agricultural drainage will require novel approaches. Experiences in temperate, industrialized societies will not provide ready guidance because most examples of recovery from eutrophication in great lakes have been accomplished through control of major point sources such as sewage treatment plants by the emplacement of tertiary treatment to reduce phosphorus effluents and the legislated reduction of P in soaps and detergents. Addressing these easily (technically) controllable sources will contribute to the reduction of nutrients in the lake and will certainly improve receiving bays and gulfs but will not alone affect a substantial reduction in the whole lake! There are far fewer cases of successful restoration of eutrophic lakes by control of diffuse sources and even fewer in the tropics.

The LVEMP studies have shown that atmospheric loading is important but the sources of the loading are ill-defined especially in a geographic sense. Will it be enough

to simply reduce atmospheric loading in the basin, or is most of the loading arising outside the basin and being transported by air masses into the basin. An expansion of the atmospheric monitoring network to the margins of the basin (and into the centre of the lake) should be a major science objective of phase 2. To reduce the atmospheric loading will likely require restoring more continuous (in space and time) vegetative cover to the catchment. Studies of soil and water conservation strategies within LVEMP 1 have demonstrated successful approaches to accomplishing this goal, and these strategies have demonstrable benefits to the implementing farmers in increased crop yields. The challenge to LVEMP 2 will be to encourage the spread of this knowledge and encourage the adoption of these practices. Studies under LVEMP and the use of catchment models for sediment and nutrient yield will allow strategic approaches to investment in soil and water conservation and land use planning at the basin scale to ensure that highly erodible areas are protected or brought into production with care given to reducing risks of erosion. Given the sensitivity of fish marketing to contaminant issues, there must be continued monitoring of atmospheric and riverine loadings of contaminants such as POPs and Hg which can lead to market and even local consumption restrictions if they begin to increase in the fish. Contamination of the Victoria fishery would be an economic and health disaster that must be avoided. Continued monitoring must go on with additional studies on how these contaminants cycle within Lake Victoria. The North American and European experience in this regard is sobering; there it has been realized that fisheries can be very slow to recover from contamination because of very efficient internal cycling within the ecosystem of many of these contaminants. Such studies were not undertaken during LVEMP 1, but the surveys of these contaminants were completed and can now form the observational basis for further studies, e.g. why does Napoleon Gulf have higher Hg concentrations in fish than Winam Gulf (Campbell et al. 2003).

Studies during LVEMP 1 have established that eutrophication through its effects on water clarity and visibility can negatively impact biodiversity. Islands with higher transparency have more species than islands with low visibility. There will be biodiversity benefits to be realized from reducing algal abundances. Reduced predation pressure on native species has allowed some of the taxa to increase as fishing pressure on Nile perch has increased. However, this "recovery" is only in a few of the many trophic groups formerly found in the lake. Habitat restoration of visibility conditions and light transparency to support benthic algal production will be necessary to accomplish a fuller recovery if the biodiversity surveys confirm that many of the species are still present in refugia within or marginal to the lake. The occurrence of several of the native species within the marginal refugia does not guarantee their survival there as these small waterbodies are under the same pressures that led to the changes in Lake Victoria. Community based management plans must be developed and implemented with communities to insure the survival of these taxa in these refugia.

Information management and dissemination will be a major challenge for LVEMP 2 whereas infrastructure, capacity building and knowledge generation dominated the LVEMP 1 agenda. The race to generate the capacity for information acquisition and the initial consolidation of the information into useful packages whether it be publications, guidelines or regulations for management has generally taken precedent over collation, organization and storage of that information with a view to facilitating future access or regular addition of new information in a standard format. There has been

substantial progress on this issue within some organizations, or in the case of fisheries management across the region with the SAMAKI database. However the general rule is that scientific staff are undertrained and that standardized, secure databases are not available to facilitate information sharing at an organization level let alone across the region. This is especially of concern in water quality where an enormous database is accreting rapidly. One of the primary uses of this data will be to reach common regional objectives and that will require easy sharing of information. There are also still outstanding issues about quality control and assurance in water quality parameteres (as well as taxonomic identifications) and the comparability of data across the region. This situation may improve by the formal end of LVEMP 1; but, it is certain that if it does not, LVEMP 2 will have to ensure that databases containing the baseline condition of the lake are standardized, comparable, accessible and secure and able to incorporate new data on monitorable indicators to support regional management and decision making. A critical use of this spatial information will be to identify the need for protected areas (ranging from totally closed areas for fishing, i.e. a marine reserve or park, to demarcation of community managed areas.

An additional challenge to LVEMP 2 will be to insure the provision of adequate and relevant information to communities and local governments for them to participate as true partners in co-management as well as designing basic monitoring programs that the communities can implement to determine if their local management objectives are met. The LVEMP studies to date have been very comprehensive and information rich but will not be useful to communities and other non-specialist interest groups in their present format. This information must be transformed (and translated into local languages) into appropriate "packages" assimilable and actionable by local governments and communities. The most advanced example of condensing a great deal of scientific information into a manageable overview of the lake environment and its fisheries is a document produced by FIRRI (2003). A similar integration of information to insure that forward environmental management is coherent and focussed at root causes of issues of concern remains an objective beyond the large amount of scientific documentation that was available for this overview. Given that LVEMP phase 1 is still focussed on completing critical studies that will provide the necessary information, data integration and reduction to define achievable and agreed upon environmental management objectives is likely to remain to be a priority activity under the early phases of LVEMP 2.

References: (still to be added)

Getenga, Z.M., E.O. Keng'ara, and S.O. Wandiga. MS. Determination of organochlorine pesticide residues in soil and water from River Nyando drainage system within Lake Victoria basin, Kenya.

THE WORLD BANK

Lake Victoria Environmental Management Project
Phase 1

Draft
Uganda Stocktaking Report

July, 2003

TABLE OF CONTENTS

Abbreviations

BMU	Beach Management Unit
CAS	Catch Assessment Survey
CBO	Community-Based Organisation
CMU	Conservation Management Unit
CPO	Community Participation Officer
DFO	District Fisheries Officer
CPIC	Community Project Implementation Committee
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FIRRI	Fisheries Resources Research Institute (Jinja)
FLT	Fisheries Levy Trust
GEF	Global Environment Facility
GIS	Geographical Information System
GOU	Government of Uganda
IDA	International Development Association (World Bank Group)
IUCN	International Union for Nature Conservation
LAN	Local Area Network
LFA	Logical Framework Approach
LVEMP	Lake Victoria Environmental Management Project
LVEMP 1	Lake Victoria Environmental Management Project, Phase 1
LVEMP 2	Lake Victoria Environmental Management Project, Phase 2
LVFO	Lake Victoria Fisheries Organization
LVFRP	Lake Victoria Fisheries Research Project (EU)
MIS	Management Information System
NES	National Executive Secretary
PRA	Participatory Rapid Assessment
USD	United States Dollars
WB	The World Bank

Lake Victoria Environmental Management Programme, Phase 1, Uganda
PROJECT DATA

Objectives	1. To maximize the sustainable benefits to riparian communities from using resources within the basin to generate food, employment and income, supply safe water, and sustain a disease free environment. 2. To conserve biodiversity and genetic resources for the benefit of the riparian communities and the global community. 3. To harmonize national management programmes in order to achieve, to the maximum extent possible, the reversal of increasing environmental degradation.
Components	• Fisheries Management • Fisheries Research • Lake Victoria Fisheries Organization (LVFO) • Industrial and Municipal Waste Management • Land Use Management • Wetland Management • Catchment Afforestation • Water Hyacinth Control • Water Quality and Quantity Management • Support to Riparian Universities
Implementing Institutions	Ministry of Water, Lands and Environment (lead agency) Ministry of Agriculture, Animal Husbandry and Fisheries National Agricultural Research Organisation National Water and Sewerage Corporation Makerere University Lake Victoria Fisheries Organisation
Start date	Mid-1997
Finish Date	End-2004
Budget	USD 23,073,480
Management	LVEMP National Secretariat PO Box 5 Entebbe National Executive Secretary: Dr F L Orach-Meza

1. INTRODUCTION

1.1. Background

The Lake Victoria Environmental Management Project, Phase 1 (LVEMP 1) was initiated in 1994 with the signing of a Tri-partite Agreement between Kenya, Tanzania and Uganda. A comprehensive planning process by the stakeholders resulted in the formulation of project documents for each country that were subsequently combined into one Project Document. This in turn was subject to a World Bank Staff Appraisal Report. IDA Board approval was given in June 1996. GEF grant funding was also approved for the project, amounting to 50% of the external financing. The three riparian governments were expected to contribute 10% of the budget.

Phase 1 started in mid-1997 for a five-year period up to mid-2002. A Mid-Term Review took place in 1999, which highlighted the slow pace of implementation and made some adjustments to the scope and strategy of the project. Supplemental Credits from IDA were approved for an additional two-year period for Tanzania and Uganda in order to complete Phase 1 activities. In Kenya, the IDA financing was closed at the end of 2002, while an extension of the unused portions of the GEF funding was granted up to the end of 2004.

Phase 1 is now seen as a preparatory phase for a longer-term input that may last 15-20 years. Planning for Phase 2 has started with a "visioning exercise" that is taking place in all three countries. Phase 2 is expected to start in mid-2005.

In addition to the Mid-Term Review in 1999, the World Bank has conducted annual Supervision Missions for the purpose of guiding the project.

1.2. Stocktaking Approach and Focus

In 2003 it was decided that, as part of the preparations for Phase 2, there was need for an independent Stocktaking of the project in order to provide an overview of what has been achieved and what lessons have been learned that are relevant for Phase 2. As part of the preparation for the external Stocktaking, the project National Secretariats in each country produced their own Stocktaking Reports. These have been appreciated and used by the Stocktaking Mission.

This report is part of the Stocktaking exercise; it is a summary of the current status of the project in Uganda. In addition to the three Country Reports, there is a Regional Stocktaking Report. Others deal with the following components or groups of components. Each of them has been made in three editions, one for each country, and those for LVEMP Uganda are annexed to this report:

- Fisheries Management and Fisheries Research;
- Industrial and Municipal Waste Management, Land Use and Wetland Management;
- Water Quality Management;
- Water Hyacinth Control.

There are two other reports that are concerned with, respectively, institutional and community participation issues:

- LVEMP 1: Policy and Institutional Framework;
- LVEMP 1: Community Participation.

The Uganda versions of these have also been appended to this report.

Finally, there is a report that summarizes the *Scientific Findings* that have come out of the project over the past six years – and this is included as an annex of the Regional Stocktaking Report.

Mission Members
The members of the Stocktaking Mission and their responsibilities were:

- Nigel Hawksworth: Policy and Institutional Support (Team Leader)
- Ian Cowx: Fisheries Management, Fisheries Research;
- Tore Laugerud: Industrial and Municipal Waste Management, Land Use and Wetland Management;
- Kevin Murphy: Water Hyacinth Control;
- Ernst Lutz: Water Quality Management (World Bank);
- John Fox: Community Participation.

Performance Ratings
This report contains the summary performance ratings of the Stocktaking Mission regarding the progress of the LVEMP Uganda components on the following scale:

Highly satisfactory: Project achieved or exceeded *all its major* relevant objectives and has achieved (or is highly likely to achieve) substantial development results.

Satisfactory: Project achieved *most of its major* relevant objectives and has achieved (or is expected to achieve) satisfactory development results with only a few shortcomings

Marginally satisfactory: Project achieved *some of its major* relevant objectives, and has achieved (or is expected to achieve) some satisfactory development results.

Unsatisfactory: Project *failed to achieve most of its major* relevant objectives, has not yielded and is not expected to yield substantial development results, and has significant shortcomings.

Highly unsatisfactory: Project *failed to achieve any of its major* relevant objectives and has not yielded (and is not expected to yield) worthwhile development results.

2. ASSESSMENT OF DESIGN, OBJECTIVES AND QUALITY AT ENTRY

2.1. Project Planning

When LVEMP – in effect, three country projects with common objectives and similar implementation structures – was planned and designed during the period 1994-97 there was a commendably high degree of stakeholder ownership of the planning process, with the draft project documents being produced by each country.

Some training was conducted in each country regarding the Logical Framework Approach (LFA) in order to create a commonality of structure and design. However, as argued in the Stocktaking Mission's LVEMP Regional Report, the training does not seem to have resulted in LFA structures that conform to the normally accepted standards. The conventional hierarchy of development objectives, immediate objectives, outputs and activities is not apparent. No outputs are indicated. On the other hand, there are innumerable objectives at the component level, and they appear to have increased over time. For example, reporting using the LFA in Uganda in 2002 shows different objectives for every activity, resulting in 145 pages of tables to describe the project.

The overall project objectives, as presented here in the introductory 'Data Box', were not put into a LFA structure. Logframes were not made for the project as a whole, for each country, or for each component. If the project had been structured in a LFA hierarchy, the three main objectives could have been development objectives. One immediate objective could have been formulated for each component, and the outputs could have been formulated so that there was one for each sub-component, each of which would have had a number of activities.

Annex 4 of the Project Document has a list of project performance and impact indicators. These have never been systematically quantified and measured at regular intervals. In fact, as suggested in the Regional Report, project management seems not to have understood the purpose of these indicators. In the Stocktaking Report produced by the LVEMP Regional Secretariat all these indicators appear as outputs. Achievements of the project are then listed in the report, but they are not directly related to the indicators/outputs, and in most cases the achievements are not quantified or documented in a convincing form. (See Annex 2 of the Regional Report for the external Stocktaking Mission's assessment of the achievements of the project in relation to the above indicators.)

The consequence of the initial imprecise planning – and the tendency to change component structures and objectives throughout implementation – is that it is very difficult properly to assess whether inputs have been used efficiently and whether outputs have been effective. And the monitoring problem is compounded by the project's inconsistency in reporting.

2.2. Project Strategy

The overall project strategy seems to have placed emphasis on data and research, rather than on key management issues of the lake. It has not been made clear how the data that

has been collected will be used – or even who will use it with regard to management decisions about the lake. A Management Information Systems (MIS) strategy was not developed, even though each National Secretariat has a MIS officer. The MIS officers have been used mainly for producing information about the activities of the project. A relevant MIS strategy would have identified who the decision-makers are concerning the lake, what sort of information they need to make informed decisions, and then describe how the information was to be collected, presented, distributed and followed-up. This would have been a core element in the planning, implementation and monitoring of LVEMP.

2.3. LVEMP Uganda Organisation and Management

LVEMP is a project of large scope and great complexity. As the Project Document says: "the project is designed to be a mixture of information gathering, capacity building, institution establishment, and actions to deal with the environmental problems of the lake..."

2.3.1. Components

The following table, showing the 10 components and 29 sub-components and pilot projects of LVEMP Uganda, illustrates the scope and complexity:

Component	Sub-Components and Pilot Projects
Fisheries Management	Strengthening Enforcement and Closed Areas (Co-Management) Strengthening Data Collection and Frame Surveys Strengthening Fisheries Extension Quality Assurance Fish Levy Trust Incorporation of Local Communities in Fisheries Management Micro-Projects
Fisheries Research	Fish Biology and Biodiversity Conservation Aquaculture Socio-Economics Research Information and Database Water Hyacinth Research
Lake Victoria Fisheries Organization (LVFO)	
Industrial and Municipal Waste Management	Management of Industrial and Municipal Effluents (Core project) ➢ Integrated Tertiary Industrial Effluent Treatment ➢ Integrated Tertiary Municipal Effluent Treatment ➢ Priority Waste Management Investments
Land Use Management	Integrated Soil and Water Conservation (Core project) ➢ Management of Pollution Loading ➢ Assessment of the Role of Agro-Chemicals
Wetlands Management	Buffering Capacity of Wetlands (Core project) ➢ Sustainable Use of Wetlands Products
Catchment Afforestation	
Water Hyacinth Control	➢ Bio-Control Programme ➢ Mechanical/Manual/Chemical Control Programme ➢ Supervision, Legislation, Dissemination and Public Awareness
Water Quality and Quantity Monitoring	Eutrophication (Core) ➢ Sedimentation ➢ Hydraulic Conditions ➢ Water Quantification ➢ Water Quality Model
Support to Riparian Universities	

As argued in the Stocktaking Report on Policy and Institutional Framework, the mixture of various types of activities described above was not prioritized. But the actual design, as shown in the type and number of components, appears to be heavily weighted in terms of research and data collection, and less on dealing with actual environmental problems. Little emphasis is evident with regard to the creation of environmental management tools for the lake. There are a large number of components and sub-components, which gives the impression of the project trying to tackle numerous issues, without a sense of priority and without a strategic vision of the outputs needed to create operational management tools for the lake as a whole. It is a structure of the project required a complicated supervision, budgeting and accounting system.

2.3.2. Implementation Structure

The project is implemented through the relevant line ministries, departments and scientific institutions listed above in the introductory Data box. Whatever staff members are deployed from these agencies work under their normal government/institution conditions of service. There is normally a task leader or head of each component.

National Secretariat

The National Secretariat, based in Entebbe on the Lake, comprises eight professional staff: National Executive Secretary, Operations Officer, Procurement Officer, Community Participation Officer, Project Accountant, Assistant Accountant, Management Information Systems Officer, and Information Assistant.

The Secretariat's functions, as defined in the Project Document, are a mix of planning and coordinating field implementation, administering the flow of funds, procuring equipment, liaising with the partner institutions, monitoring progress, assisting in setting up data-bases, designing and disseminating publicity materials.

Implementation Committee

The National Executive Secretary (NES) is Chairman of the Project Implementation Committee, which is an internal committee composed of task leaders, coordinators, senior scientists and secretariat staff. It is supposed to meet every month to review component progress, annual plans and quarterly reports. It is a useful body for dealing with technical implementation issues. However, the fact that it is chaired by the NES makes it an internal body in what is in effect a self-regulating project. It was reported to the Stocktaking consultants that a few heads of the implementation agencies feel that an equal footing is lacking in terms of dialogue, coordination and facilitation. The structure of the project appears to allow for a dominating role of the NES, if the management style is inclined in that direction. It is argued in the Policy and Institutional Framework Report that a National Policy and Steering Committee, chaired by the lead Permanent Secretary or in rotation by the involved Permanent Secretaries, with the NES as secretary of the committee, would ensure coordination and supervision at the highest possible level.

Other matters relating to Secretariat costs, employment conditions, budgeting and financial flows, data management are treated in detail in the Policy and Institutional Framework Report.

The following chapter puts the focus on the performance of the eight components of LVEMP Uganda – and also on the effectiveness of its community participation strategy.

3. ACHIEVEMENT OF OBJECTIVES AND OUTPUTS

For LVEMP Uganda, as for the projects in Kenya and Tanzania, project progress has been slower than was envisaged in the Project Document and World Bank Staff Appraisal Report. Even without precise and measurable targets and outputs, it was apparent that the first two years were not very productive. Much time was taken with the establishment of the secretariats and the components, and with setting management, financial and procurement procedures. In Uganda, as in the two other countries, it was found necessary to extend the project closing date by two years in order to reach a stage where it would be possible to achieve most of the objectives.

As argued in the previous chapter, because of the lack of adequate logframes for the project as a whole and its components, it is difficult to assess achievement in relation to defined and monitored objectives and outputs. This chapter will therefore examine the achievements in relation to what the Stocktaking Mission has been able to deduce as being the objectives and outputs. Each section of this chapter is a summary of the progress of each component, as presented in the component-specific reports identified in section 1.2 above. There is also a summary of the finding of the special report on the community participation strategy of LVEMP Uganda.

It should also be noted that, under the title "Support to Riparian Universities", the project has provided support to the Zoology Department Makerere University, in the form of scholarships, infrastructure and equipment.

3.1. Fisheries Management

Overall Objective: *To promote, support, guide and ensure proper management and optimum utilization of the fisheries and other resources of the lake and its basin for the benefit of the people of the riparian partner states.*

3.1.1. Strengthening Enforcement and Closed Areas (Co-management)

Significant progress has been made in achieving the primary objective of introducing co-management into the lakeshore fishing communities:

- The Fisheries Act has been reviewed; a draft National Fisheries Policy for Uganda is under review and being discussed with stakeholders.
- Gazettement of BMUs has progressed in preparation for their role in co-management.
- Critical questions about the formation and support of beach management units (BMU) are being addressed.
- An extensive monitoring programme has been put in place and numerous gears have been destroyed, undersized fish confiscated, persons arrested and vehicles impounded.
- Progress on harmonising legislation within the region is slow – and his should be completed by the end of LVEMP 1

(Rating: Satisfactory)

3.1.2. Strengthening Data Collection and Frame Surveys

The sub-component has been poorly planned and implemented. It has failed to deliver on a number of aspects:

- A regional frame survey undertaken in March 2002 has yet to be reported – despite the availability of the SAMAKI database, with its specific module for the frame survey.
- The catch assessment component of the fisheries database sub-component has failed to materialize in Uganda – few data have been collected since the mid-90s.
- Studies to develop the CAS programme using BMUs have started but have been hampered by inadequate planning and poor flow of funds – a simple catch assessment protocol should be designed.
- The Stocktaking Mission recommends that database development and management should become a central function of LVFO – and a priority under LVEMP 2.

(Rating: Marginally satisfactory)

3.1.3. Strengthening Fisheries Extension

A sub-component that covers a wide range of activities, including awareness campaigns about lake fisheries issues, micro-projects, aquaculture extension:

- Over 400 workshops have been carried out on aquaculture and fisheries management topics.
- Most interventions have been through BMUs.
- Manuals have been distributed on fish farming methods.
- But there is no strategic plan to ensure wide coverage – nor is there a systematic appraisal of activities.
- Draft National Aquaculture Action Plan document has been produced.

(Rating: Satisfactory)

3.1.4. Quality Assurance

A sub-component that has a strategic role to play in the development of Lake Victoria fisheries (most efforts have been brought to bear on the Nile Perch fishery, but much of the output is also relevant for tilapia and other high value species:

- Manuals on improving fish handling practices have been developed and distributed – but they remain in draft form.
- Awareness raising campaigns have been mounted – leading to a more widespread use of ice, more hygienic handling practices, reduced post-harvest losses and improved quality of, particularly, Nile perch.
- The daft regional guides for fish inspectors should be formalised and distributed.
- The laboratory for testing fish quality to met ISO standards is not fully operational and chemicals bought under LVEMP have passed their expiry date.

(Rating: Marginally satisfactory)

3.1.5. Fish Levy Trust

No fish levy trust, or informal arrangements for collecting revenues from fisheries, exist in Uganda:

- A study by Norconsult was carried out in 2002 on current taxation and licensing related to the fisheries industry – but there has been a delay in implementing the recommended 1.5% levy.
- It is recommended that the Uganda and Kenya FLT reports should be reviewed – and also consideration should be given to the informal procedures adopted in Tanzania.

(Rating: Marginally satisfactory)

3.1.6. Incorporation of Local Communities in Fisheries Management

Progress has been made in sensitising and training BMUs in monitoring, surveillance and management of fisheries – and in improving fish quality at the landing sites:

- Two stakeholder workshops have been held for the 10 districts bordering Lake Victoria; 40 fish landing communities sensitised.
- 273 fisherfolk have been trained in business management and marketing skills; 41 micro project committees and 13 DFOs have been trained in book keeping and simple accounting.
- A booklet on co-management has been produced and distributed to stakeholders.
- Data collection has come to a halt in pilot areas because of a lack of incentives.

(Rating: Highly satisfactory)

3.1.7. Micro-Projects

In Uganda, implementation of the micro-projects programme is through the Fisheries Management Component. It is briefly reported on here – and also a number of concerns about the programme are taken up in section 3.10 below:

- A total of 40 micro-projects have been funded – out which 24 have been completed. An elaborate system has been set up for identifying and approving micro-projects through community consultation – but it seems that the selection of projects is heavily influenced by the views of the district officials undertaking the community sensitisation exercises.
- With regard to the seven projects that failed to complete their activities, it is eported that they were either under-budgeted or the community did not contributed the expected 10% of costs.
- The programme has increased the capacity of communities to tackle their own problems, reduced travelling distances to health facilities, increased school classrooms, improved sanitation on beaches – and promoted a positive image for LVMP Uganda.

Details of the micro-projects and the selection/supervision mechanisms are in the separate and appended report on Community Participation in LVEMP Uganda.
(Rating: Marginally satisfactory)

Overall rating for the Fisheries Management Component: Marginally satisfactory

3.2. Fisheries Research

Overall Objectives: *To provide information on the ecology of the lake and its catchment, the biology of its flora and fauna, the impact of environmental factors on the lake system and socio-economic implications of use of the lake resources; restoration and sustainable survival of several endangered and threatened species of fish through aquaculture fish farming; increase fish production through appropriate aquaculture technology and practices.*

3.2.1. Fish Biology and Biodiversity Conservation

The potential overlap with the LVFRP is recognised. The main achievements have been:

- Information on the distribution of native fish species has been collated, and some aspects of the biology and ecology of these species has been described.
- Field surveys have been carried out in pilot areas to generate information on aquatic biodiversity.

- There has been little analysis to explain the factors contributing to the status of the biodiversity.
- Many papers, brochures for conferences and journals, and chapters for books have been produced, but little of this information is in its final published form.
- However, there has been good infrastructure development, related to research vessel, aquaria in six locations, and improved display facilities at FIRRI.
- Considerable investments have been made in post-graduate training for scientists and technicians – though there is concern about whether studies will be completed.

(Rating: Satisfactory)

3.2.2. Aquaculture

The specific objective is to improve food security for the communities living in the lake basin through improved aquaculture production and restoration of stocks of previously important commercial species of Lake Victoria. These are the most notable achievements:

- Inventory of potential fish farms in the regions.
- Rehabilitation of Kajjansi fish farm.
- Technologies developed to breed *Labeo victorianus*.
- Increased production of *Nile tilapia* and *C. gariepinus* fry for distribution to fish farmers.
- Feeds developed for *L. victorianus* and *C. gariepinus*.
- Fish farmers trained in pond management and participating research programmes initiated.
- Aquaculture extension material developed for fish farmers.

However, there has been little progress with the economic and financial analysis of the efficacy of fish farming practices – and the participatory research programme is weak. No exit strategy has been defined – even though there seems to be only marginal Government support for aquaculture in Uganda.
(Rating: Marginally satisfactory)

3.2.3. Socio-Economics Research

The sub-component has suffered through lack of suitably qualified staff – and the diversion of allocated resources. Nevertheless, remarkable progress has been made in the last two years, and the following are some of the most notable achievements:

- About 300 socio-economic publications on Lake Victoria have been reviewed – but no formal report produced reports.
- A survey on community involvement in the fishing industry has been compiled and a draft report produced.
- A survey, which included three district level workshops, on the impact of fishery activities on fisheries resource degradation and the environment, including trees/forests, shrubs and grass, wetlands, domestic, human and fishery wastes was conducted and reported.
- A survey on the nutritional status, health and social amenities of the lakeside communities was conducted and the information disseminated in three district level workshops....

However, much of this output is of an academic nature and the information needs to be translated for use in carrying out fisheries operations or making management decisions. Also, more effective mechanisms need to be developed for disseminating research findings to fisherfolk and resource managers.
(Rating: Highly satisfactory)

3.2.4. Information and Database

Remarkable progress has been made:

- The FIRRI infrastructure for information collation and dissemination is now well provided for and should be used as a model for the two other countries.
- FIRRI also has the potential for being an information provider linked to the LVFO and act as a regional focus for all issues pertaining to information technology.
- Problems have, however, been encountered with the completion of the Library/Data Centre building and funds should be released to complete this action.
- Development of the SAMAKI database is a joint initiative with the Frame Survey/Catch Assessment sub-component under Fisheries Management, but there appears to be little exchange between players in each sub-component.

(Rating: Highly satisfactory)

3.2.5. Water Hyacinth Research

In Uganda, the research aspects of water hyacinth control were taken up by FIRRI. The overall objective of the component is to generate information, develop methods and offer advice to guide control of invasive weeds, especially water hyacinth, but more specifically for the research programme to determine the impact of environmental degradation by water hyacinth on the lake fisheries:

- Current outputs comprise a number of draft reports, papers and brochures.
- A PhD thesis is also expected by the end of 2003.
- The sub-component has also created awareness of the water hyacinth problem and issues of control with lakeside communities, but studies on the socio economic implications of water hyacinth proliferation have not been carried out.
- Another area that has received little attention is why biological control of hyacinth in rivers has not been successful.

A more detailed assessment of LVEMP's role in water hyacinth control is given in the report of the consultant carrying out a stocktaking of the specific component – and the summary of that report is in section 3.8.
(Rating: Satisfactory)

Overall rating for the Fisheries Research Component: Satisfactory

3.3. Lake Victoria Fisheries Organisation

***LVEMP objective for LVFO**: To establish a functional Secretariat for the LVFO.*

The LVFO has been successful is harmonising and co-ordinating fisheries activities, including activities from different donor projects. They have forged partnerships between institutions and stakeholders, and have played a major role in helping resolve issues pertaining to the fisheries sector, for example lifting the EU export ban and cross-border fishing. It has also played a role in harmonisation of legislation, improving fish handling practices and quality control procedures, and is the repository for the Fisheries Management Plan for Lake Victoria which will be implemented under Phase 3 of LVFRP. These are major achievements of the organization, but it should be recognised that many were supported by funding from other donor agencies (e.g. EU, IUCN, FAO/COMESA).

Notwithstanding the achievements, the LVFO have fallen short on several aspects:

- The LVFO was the coordinator of the regional frame surveys in 2000 and 2002. Unfortunately, reporting of these activities is slow and the 2002 survey results have yet to be published.
- Regional database harmonization meetings have suggested a multi-module database to encapsulate all environmental and biological data. Because of considerable delays, LVFRP constructed the SAMAKI database for fisheries applications, which is being used for the frame survey reporting. However, little other data have been captured, and the wider expansion to incorporate other biological, environmental and sociological data has not materialised.
- There has been weak harmonisation of the outputs of fish levy trust studies from each country with little advice being given on the issues raised.
- LVFO was expected to produce regular fishery statistical bulletins for dissemination to the region, but no regular output has been found, in part, presumably, because of the lack of formal statistical reporting mechanisms in the riparian countries.
- Although the LVFO has been instrumental in coordinating several meetings and workshops, e.g. LV 2000, a New Beginning, the first international conference on Lake Victoria, and the first regional workshop on the Role of Women in Fisheries Management of Lake Victoria, output from these meetings is lacking.
- The quality and frequency of publications through the African Journal of Tropical Hydrobiology and Fisheries remains variable.
- There is little strategic planning of activities with well defined objectives and milestones of achievement. LVFO activities to date seem to more project driven and they needs to focus more on the regional vision which underpins the organisation's activities.
- It is recognised that continued collaborative efforts between LVFO and LVEMP components in all three countries on activities such as the frame surveys (a regional initiative), regional harmonization of fish quality standards, and database maintenance (fisheries statistics) may suffer without support from LVEMP components, specifically to fund coordination. (There is a further discussion of LVFO in section 5.1.1 – in relation to sustainability issues.)

Overall rating: Marginally satisfactory/satisfactory

3.4. Industrial and Municipal Waste Management

Overall Objective: *The overall aim of the programme is to improve management of industrial and municipal effluent, and assess the contribution of urban runoff to lake pollution in order to design alleviation measures.*

Again, the following summary of the Stocktaking Mission's findings is organised according to sub-components or pilot projects.

3.4.1. Core Project: Management of Industrial and Municipal Effluents

- In relation to establishing the geographical location and nature of all factories/industries (and any potential pollution sources) in the catchment, an inventory has been established with data for 104 industries and 103 urban centres.

- Pollution loads have been quantified for 14 industries in Kampala – but less than the planned point-source pollution spots have been surveyed.
- Pollution loads from industrial, municipal and shoreline settlements have been quantified and pollution hotspots classified.
- Zoning of pollution hotspots has been done and main pollution sources found. (Kampala contributes up to 65 % of the organic load.)
- A management tool is in place for assessing the dilution/dispersion level of the effluent in the receiving water body.
- The number of people receiving relevant post-graduate and skills training is less than anticipated.

(Rating: Satisfactory/Marginally satisfactory)

3.4.2. Integrated Tertiary Industrial Effluent Treatment

The objective was to investigate the viability of using constructed wetlands in the tertiary treatment of industrial waste using a pilot scale. The project's reported achievements were:

- An operational constructed wetland has been established.
- Operation and monitoring of the pilot plant is done and a database has been established and is continuously maintained.
- Public awareness through demonstration of tertiary treatment of industrial effluents has been going on for three years.
- Papers on tertiary treatment using the pilot project have been presented in various forums. A brochure of the pilot project is being prepared and a documentary has been done pending editing.

However, activities are significantly delayed and there are no proper replications so far.
(Rating: Marginally satisfactory/Satisfactory)

3.4.3. Integrated Tertiary Municipal Effluent Treatment

To investigate the viability of using a well managed natural wetland on a pilot basis in the tertiary treatment of municipal waste, the project reports:

- Access transects for monitoring of the wetland are regularly maintained.
- Baseline data on the water quality of the stabilisation ponds, in the wetland and in the Napoleon Gulf are collected.
- Wetland vegetation and socio-economic activities around the wetland are documented. Construction of the wastewater distribution system is complete and is being optimised.

However, activities have been significantly delayed; there has been no proper documentation of results; and no replicability has been initiated.
(Rating: Satisfactory/Marginally satisfactory)

3.4.4. Priority Waste Management Investments

The level of ambition of this sub-component was significantly scaled down through re-formulated objective to rehabilitate the Bugolobi Treatment Works:

- Activities have been delayed and there is still a non-compliance with standards.
- Two generators have not been commissioned and the dosing unit has been taken out.

(Rating: Marginally satisfactory)

Overall rating for the Industrial and Municipal Waste Management Component: Satisfactory

3.5. Land Use Management

Overall Objective: Develop appropriate land use practices involving both soil and water conservation and use of agricultural chemicals that will reduce land degradation and nutrient and sediment loading into water systems, and enhance the productivity of land and water to ensure their sustainable utilisation.

3.5.1. Core Project: Integrated Soil and Water Conservation

- Progress has been made with quantification of soil erosion and nutrient loss from a range of land use practices, through PRA exercise in selected micro-catchments, but post-graduate theses are still outstanding.
- A number of relevant micro-projects have been promoted, but no proper synthesised reports on interventions have been produced.
- Good progress has been made in sensitising communities on the importance of soil and water conservation – through demonstrations, field days for farmers and schools, publications, posters and a video – but more areas need to be covered.

(Rating: Satisfactory)

3.5.2. Management of Pollution Loading into Lake Victoria

- In establishing baseline data on nutrients loading in the main rivers in the catchment, the project reports that three hydro-stations were constructed in Kakuuto & Kyotera sub-counties and river discharge patterns established, as were trends in pollution loads from agricultural land.
- 25 rain gauges established in Rakai and Mayuge districts; a climatic weather station established and equipped at Rakai district headquarters; the rainfall data collected has been analysed and passed onto district and other stakeholders for use and planning.
- Preliminary reports on land resource inventories and land use/cover reconstruction and mapping have been produced, and detailed land use maps are still being developed. However, the database report is still to be produced.
- Four post-graduate studies have been supported.
- Preliminary reports on land resource inventories have been produced.

(Rating: Marginally satisfactory)

3.5.3. Assessment of the Role of Agrochemicals in Pollution

- A database of agrochemicals is in place and is being updated.
- An information bulletin is being produced.
- Field trials to monitor movement/persistence/transformations of selected herbicides have been carried out at Kakira Sugar Estate – but the final reporting is outstanding. Workshops/seminars are regularly held for sensitising dealers/stockists, extension workers and other stakeholders on the safe handling and use of agro-chemicals. Information is disseminated through journal articles, conference papers, posters/brochures and a video documentary (aired on national stations).
- It is claimed that the component changed the Government's mind on the re-introduction of DDT for malaria control.

(Rating: Satisfactory/Marginally satisfactory)

Overall rating for the Land Use Management Component: Satisfactory

3.6. Wetlands Management

Core project objectives: *To develop an inventory and classification of the wetlands, monitor nutrient loading in priority areas, simulate the changes of buffering function associated with threats to the wetland resources, assess the economic value of buffering functions, and prepare guidelines and investment proposals for introducing wastewater into wetlands, as well as rehabilitation and artificial wetland construction.*

3.6.1. Core Project: Buffering Capacity of Wetlands

- The project reports that all wetlands in the catchment have been inventoried and mapped, but the report and map compilation remain.
- A cost benefit analysis of the Lake wetlands has been completed, and the report will be disseminated in a 'popular form' to the public and politicians.
- A number of awareness raising activities have been launched about the nature and consequences of threats to the wetlands – through such means as radio spot messages, bill boards public meetings and the development of District Wetland Management Action Plans – but perhaps not enough attention has been paid to the action plans, and the impact of the awareness raining campaigns has not been evaluated.

(Rating: Marginally satisfactory)

3.6.2. Sustainable Use of Wetland Products

The project is designed to estimate the economic benefits from wetlands products (fish, papyrus, reeds, clay, livestock grazing, and agricultural products), develop management strategies for their sustainable use, and for the rehabilitation of specific degraded wetlands, evolve strategies for community participation in sustainable use, initiate pilot activities to demonstrate this use, and strengthen capacity of local NGOs and CBOs to undertake wise use activities:

- In three pilot areas, there has been a documentation of public attitudes to wetland products.
- Background data has been collected for the formulation of marketing strategies. But management and marketing strategies are still outstanding.
- Numerous demonstrations have been given on the use of wetlands resources – but the concentration has been on handicrafts.

(Rating: Marginally satisfactory)

3.7. Catchment Afforestation

Overall objectives: *To protect vital parts of the lake catchment by planting trees, increase awareness among communities on catchment protection and tree farming, develop local seed sources, improve management of existing forest reserves and create new reserves, and conserve forest biodiversity.*

- In improving forest reserves, the project reports: identification of six forest reserves for rehabilitation; replanting of 223.5 ha of degraded forest areas; reopening and maintaining 20 km boundary length of Mwiri and Nabanga forest reserves; protection activities in some 670 ha of forest reserve – and related protection activities
- No new forest reserves have yet been created, owing to legal constraints.
- In promoting the conservation of forests outside forest reserves, there has been stakeholder sensitisation through mass media and exhibitions during public events;

promotion of on-farm tree growing by establishing and maintaining a total of 3.7 ha of on-station agro-forestry demonstration plots and some on-farm demonstration establishments; preparation of two Community Action and Management Plans for rehabilitation in Rakai district; technical and material support offered to various stakeholders for the establishment of plantations outside forest reserves.

- In strengthening institutional and stakeholder capacity for the effective management of forests, equipment has been procured for district forestry extension staff and participating community groups.
- In promoting tree growing, materials and technical support have been to local communities, groups and institutions for tree seedlings production and management in 27 tree nurseries; 10 central nurseries have been established and the ownership of five have been divested to local stakeholders, with an average seasonal production capacity of 80,000 seedlings.

Overall rating: Satisfactory

3.8. Water Hyacinth Control

Overall objective: To establish sustainable long-term capacity for maintaining control of water hyacinth and other invasive weeds in the Lake Victoria Basin.

The main objective was clearly achieved, within the limits imposed by pollution problems on the lake, resolution of which problems were outside the remit of the component. The residual hotspots of water hyacinth infestation, largely related to these nutrient-polluted areas have, however, been clearly identified during Phase 1, and sensible plans have been put forward to deal with the problem in a long-term sustainable manner during Phase 2. The following are the main findings related to the four sub-components or "elements":

- Biological control: 6 of the 7 objectives were achieved with "Highly Satisfactory" or "Satisfactory ratings". The seventh objective (reducing weed inputs from the Kagera River to the Lake) was only "Marginally Satisfactory". However, useful lessons were learned, and the work done has clearly identified this issue as one which needs considerable additional management attention, and research activity, during Phase 2.
- Mechanical/manual/chemical control programme: both of the main objectives (mechanical and manual control) were achieved and, despite a few minor problems, their outcome can be considered 'Highly satisfactory".
- Supervision, dissemination, legislation and public awareness: for this component, with its very clear and concrete main objective, it could be argued that success in meeting these subsidiary objectives has a relatively low priority, and less effort has gone towards activities aimed at meeting these objectives.

3.9. Water Quality and Quantity Monitoring

Development objectives: To determine the level of eutrophication of the lake; to obtain data on sediments particulate and to monitor vertical sediment profiles of dissolved and particulate nutrients; to understand how the hydrodynamics of the Lake affect the nutrient loading/mixing, and the flora and fauna; to quantify water inflows and outflows/evaporation; to develop simulation models of the dynamics of nutrients and

phytoplankton which then would be used to predict eutrophication control programmes and pollution intervention strategies.

3.9.1. Core project: Eutrophication

- An in-lake water quality monitoring system has been established, consisting of 28 stations jointly designed by Tanzania, Kenya and Uganda.
- Data collection reached its high point during the period of the COWI contract (20 months period in 2000 and 2001), when three workshops were held during which the countries shared their available data at that time, and when a significant report was produced.
- The laboratory is in good working condition with appropriate equipment, but with inadequate number of samples for analysis.

(Rating: Satisfactory)

3.9.2. Pilot Project: Sedimentation

This was initially implemented by Makerere University. Because of implementation problems it was transferred to the Water Resources Management Department:

- For the COWI work rough estimates were produced.
- Samples are being taken monthly in the three major rivers but sampling in the Lake has been intermittent due to limited availability of research vessels or other constraints. Analysis of samples is weak.

(Rating: Marginally satisfactory)

3.9.3. Hydraulic Conditions

During the COWI consultancy, much data was collected, shared in three workshops with the other countries, and then integrated.
Since then (November 2001) data continues to be collected, but only in irregular intervals because of the constrained availability of a research vessel and also flow of funds problems.
Data is being collected using an advanced system, but the data cannot be analyzed due to lack of a software package.
(Rating: Unsatisfactory)

3.9.4. Water Quantification

Uganda operates three meterological and three river discharge stations. Ideally, monthly measurements should be taken, but because of various constraints only about six measurements are being taken each year. Up to the arrival of COWI, no work was done together by the countries. During the COWI period, inflows and outflows were estimated.
(Rating: Marginally satisfactory)

3.9.5. Water Quality Model

- A Water Quality Framework Model consisting of three modules (hydrodynamic, water quality, and water hyacinth) has been delivered by the consultants (Delft Hydraulics in association with HydroQual).
- Preliminary calibration has been carried out, but as of today the model is not operational. It seems to be too complicated – simplified input and output modules should be developed and staff training undertaken, but it is unlikely that this work can be brought to a satisfactory conclusion before the end of the project.

(Rating: Unsatisfactory)
Overall rating: Satisfactory

3.10. Community Participation

The separate report on the community participation strategy of LVEMP Uganda reviews the progress and achievements made with the range of micro-projects that were promoted through the Fisheries Management Component and that have been referred to in section 3.1.7 above. The report also records the many other positive community participation initiatives taken by those other components that involve community-based activities. What follows is a summary of four key findings of the Stocktaking Mission.

3.10.1. Programme Design and Staffing

That the Community Participation Officer in Uganda, as in Kenya and Tanzania, was not appointed until after two years into the implementation of the project meant that it has been very difficult to exercise a stimulating and coordinating role – on behalf of community participation – across the different components. Also, there have been no opportunities so far for the three CPOs to meet, share ideas and materials.

3.10.2. Micro-Project Programme Focus

In Uganda a wide angle view has been taken in the selection of micro-projects. Of the 40 projects, seven have been related to health facilities and four to schools. It seems, from field visit observations, that such projects are being implemented without the application of sufficient technical expertise and without the provision of necessary staff and equipment – especially when there has been insufficient consultation with either the Ministry of Health or the Ministry of Education. A second concern is that such initiatives overlap with other community development projects in the target areas. And a third concern is that a demonstration opportunity has been lost for focusing the micro-projects programme on activities that mirror the environmental conservation and resource utilisation objectives of LVEMP.

3.10.3. Linkages with Local Government Structures

Despite statements in the operational manual that the micro-projects programme would, in keeping with the Government's commitment to decentralisation, be promoted in relation to "existing structures and community development programmes" and would "act through and with full support of participating District Councils", in practice there seems to have been a tendency to hold off what is regarded as "political interference".

3.10.4. Capacity Building

The community project implementation committees (CPICs) have all received some training related to such basics as business skills and bookkeeping. And there have been numerous workshops, for both communities and technical staff, on various conservation issues and techniques. But relatively little has been done to equip the front-line technical or extension staff with the project-support communication skills related to the stimulation and coordination of community participation in the planning and management of development projects. Moreover, if LVEMP had worked more closely with local authorities, then to build the community consultation and community development skills of front-line extension staff, district-based technical staff, and also councillors, would have meant a greater chance of the community participation aspects of LVEMP being sustained.

Overall rating: Marginally satisfactory

4. MAJOR FACTORS AFFECTING IMPLEMENTATION AND OUTCOME

4.1. General Factors

There are five general factors that have significantly influenced the implementation and outcome of LVEMP Uganda:

4.1.1. Flawed Planning Process

The project planning process, using a flawed logical framework approach, has resulted in a lack of precise objectives and outputs whose impact can be measured by indicators. This has led the project to concentrate on individual activities, which have not been bound together by a strategy leading to the overall objectives.

4.1.2. Research Focus

The design of the project and subsequent adjustments through the Mid-Term Review and the Supervision Missions has maintained the project primarily as a data collection and research orientated exercise. The lack of an overall strategy leading to a set of management tools for the Lake is the reason why data is still not focused on creating an integrated on-going assessment of the state of the Lake.

4.1.3. Un-prioritised Reporting

Project design has affected the subsequent project reporting, which does not give the external observer a precise picture of achievements. This has a negative effect on the external perception of the project and its outcome.

4.1.4. Delayed Procurement and Disbursement

During the first five years of the project, despite a slow start, the flow of funds, procurement and auditing have been in general been satisfactory. Disbursement has not been a problem until 2003. However, it is now a major problem because of the delay in approval from the Ugandan Parliament.

4.1.5. Unstable staffing patterns

The project has not been able to adjust to the on-going decentralisation process in Uganda in a manner that would ensure no disruption of project activities. Decentralisation, restructuring and retrenchment in the civil service have resulted in a reorganisation of the district administrations. This has led to a removal of some staff that had been engaged on part-time data collection for the project. An example is catch data from fishing landing sites, which has virtually stopped because the district staff are now not available to do this.

4.2. Project-Specific Factors

4.2.1. Fisheries Management and Fisheries Research

- Senior personnel away from the project for extend periods of time whilst training.
- Lack of suitably trained personnel, especially in the field of socioeconomics.
- Failure to appraisal the outcomes/impact of the various activities, and lack of follow up of extension activities, especially for aquaculture

- Inadequate appraisal of budgets for micro-projects; poor sensitisation of the communities over the expected problems and potential benefits associated with micro-projects; delays in the processing of payments to communities due to lack of funds in the project special account.
- Weak feedback of information to the stakeholders.

4.2.2. Industrial and Municipal Waste Management; Land Use Management, Wetlands Management and Catchment Afforestation

- Lack of competent institutional staff at the start-up of the various activities that, together with the lack of equipment, vehicles, etc, caused delays for up to two years; and the high staffing turnover (notably in the Catchment Afforestation Component) has caused some confusion and marked delays in the activities.
- That several key staff members were sent abroad for higher training caused delays and frustration amongst the remaining staff.
- Divisive consequences of the envy felt by office-based staff for those who benefit from travel allowances.
- Lack of data compilation and synthesising/reporting from the monitoring activities (notably pollution loading, run-off testing, etc.) seems to be (at least partly) due to the fact that the components in question are too much steered/influenced by "scientists and researchers", and not by "practical implementers".

4.2.3. Water Hyacinth Control

- The speed with which the weed problem was brought under control was quite rapid but by no means exceptional. The well-undertaken active release programme was, in the Stocktaking Mission's view, a major contributory factor which aided this rapid control.
- The situation in the hotspots represents a combination of factors that have impeded success in these areas. A lack of adequate baseline knowledge of the spatial distribution of nutrient-enriched water conditions in the lake (which were not the remit of the component to assess, and for which few data were available anyway in the 1990s) would have made it difficult or impossible to predict how the agents would respond under varying conditions.

4.2.4. Water Quality and Quantity Monitoring

- In common with other components of LVEMP Uganda, this component highlights procurement and financial flow constraints as major factors impacting on implementation and outcome.

5. SUSTAINABILITY

5.1. General Factors

5.1.1. Lake Victoria Fisheries Organization (LVFO)

As described in section 3.3 above, LVEMP Uganda has supported the establishment of the LVFO, which is now part of the East African Community as an autonomous regional body coordinating the harmonization of measures to promote the sustainable utilization of fisheries resources. The LVEMP project of support to LVFO is considered complete. Funding was provided as a grant through GEP, and terminated as planned at the end of 2002. However, sustainability is not assured, as there is a shortfall of about 50% to cover the operational expenses of the organisation. The member states have increased their contribution from USD 70,000 to USD 100,000 each per year, but that covers only half of the projected 2003/04 budget. Staff salaries, benefits and allowances constitute 76% of the 2002/03 budget. A deficit of USD 193,000 is projected in 2003/04. The LVEMP National Secretariat considers that LVEMP has done what it should and it is now up to the member states to cover the operational costs. The Stocktaking Mission considers it surprising that no arrangements were made to ensure some continuity of support for LVFO after the termination of LVEMP. It appears that the staffing pattern and costs can and must be streamlined if large deficits are to be avoided. The Stocktaking Mission finds that LVFO should take the initiative in getting the stakeholders in sustainable lake management, including the World Bank, the EU and the three governments, to discuss possible scenarios for its future.

5.1.2. The Fish Levy Trust

The LVFO sub-component of the Fisheries Management Component was intended to set up a mechanism for collection of revenues from fisheries activities that were to be earmarked for sustainable management of the resources of the Lake, including support to LVFO. As discussed under 3.1.5 above, this sub-component has not produced the desired output.

5.1.3. Capacity Building

Capacity building has taken place through the provision of academic and other types of training in the form of seminars, regional visits, short courses and long-term post-graduate degree courses for a large number of the professionals associated with implementation of the project. Capacity building in the form of training was provided for under each component. Each implementing agency provided an annual training plan, which was coordinated by the National Secretariat and approved by the World Bank. There was budget provision for 5 PhDs, 33 Masters, 200 stakeholder workshops and 650 short-term and on-the-job training opportunities. However, the Stocktaking Mission finds that the training plans were not based on a training needs assessment that took into account the environmental management needs of the lake. A more systematic approach to capacity building would have directed the project towards creating sustainable structures and procedures related to management of the lake.

5.1.4. Policy and Regulatory Framework

There has not been a systematic attempt to create environmental management policies, procedures and regulations for the lake, except in the case of fisheries legislation that was identified as a sub-component at the time of project design. Such an attempt would have

been an integral part of project strategy if there had been some focus on management aspects of the lake, rather than the focus being largely on research and data collection.

5.1.5. Secretariat

LVEMP 1 was not designed to create a sustainable Secretariat, and there was no such need at that time. A phasing-out and sustainability strategy will be appropriate in the last phase of support for LVEMP in order to ensure that Uganda can sustain an appropriate structure for environmental management of the Lake.

5.2. Component-Specific Factors

5.2.1. Fisheries Management and Fisheries Rserach

- Draft National Fisheries Policy, now under review, would update legislation and empower BMUs to undertake management, but they will need continuous support.
- Since many of the sub-components were largely research orientated and therefore sustainability is difficult to evaluate. They are largely funded from external sources and thus time-limited. Without such donor interventions they are unlikely to be sustainable in the long term, unless an alternative funding mechanism is found.

5.2.2. Industrial and Municipal Waste Management, Land Use Management, Wetlands Management, Catchment Afforestation

- There is a need for increased law enforcement to create incentives for actions.
- Promotion of integrated soil and water conservation measure demands continuous awarcness raising activities.
- With regard to agrochemicals, a countrywide quality control system is needed.
- In relation to the buffering capacity of wetlands, there is a need for guidelines to be put in place. And in relation to the sustainable use of wetlands products, some good examples could be replicated – but there is a need for sound market analysis.
- For afforestation schemes, activities will not be sustainable as log as the project is buying the bulk of the seedlings produced in the nurseries. But the policy of handing the nurseries to private groups should contribute to sustainability.

5.2.3. Water Hyacinth Control

- The successful introduction of insect bio-control agents should result in self-sustaining low levels of water hyacinth growth around most of the shoreline zone of the Lake which is vulnerable to aquatic weed growth.
- This situation is less sustainable under the present management regime in the water hyacinth hotspot areas, where continued active management by mechanical and manual control measures is needed.

5.2.4. Water Quality and Quantity Monitoring

- The continued collection of data is not assured beyond Phase 1 without donor funding; given the research nature of the work, grant funding would be appropriate.

6. BANK AND BORROWER PERFORMANCE

6.1. Bank

The Bank was not solely responsible for design of the project. In fact there was a commendably high degree of stakeholder ownership of the process, with the draft documents being produced by each country. However, quality assurance from the Bank could have ensured that the project was designed to be more manageable, that there was a proper a Logical Framework Approach, and that it was focused on the high priority issues.

Supervision by the Bank has been done annually. Supervision/reviews of projects should provide critical new thinking that continuously guides the project towards its objectives. The objectives of the project are very broad, so there is ample room for relevant new initiatives and approaches towards reaching the objectives. This does not appear to have happened to much extent. The supervision mission reports have been detailed comments on on-going activities. In this regard they have been useful for the implementation staff, especially after the Mid-Term Review when the reports started to summarize actions to be taken in tables and then followed-up on these in the next report. What was lacking was new thinking, and references to best practices and lessons learned from similar activities in the region. There may have been a problem of too much continuity in the supervision missions. The same persons participated again and again, and the result appears to be too much repetition. A more open supervision process might, for example, have seen the necessity for a data management strategy leading to regular reporting on the state of the environment of the lake.

The supervision mission reports are difficult reading for persons not intimately familiar with the project. The layouts are dense texts with few headings and little sense of organization or priority.

6.2. Borrower

6.2.1. Institutional Issues

There has been an appropriate and reasonably effective role and institutional setting of the National Secretariat in relation to the project implementing agencies. The implementing agencies have been the technically qualified line ministries and their departments. It can be expected that project procedures and results have to a certain extent been disseminated into and accepted by these parent institutions. The Secretariat has been criticized by some component mangers for being too dominating and interfering in implementation matters, rather than being facilitating. The weakness in the management structure was the lack of a national steering committee composed of high-level representatives of the implementing agencies, which would have made for more equal relationships.

6.2.2. Financial Issues

The normal 10% contribution required by the Bank was reduced to 5% in the case of Uganda. The 5% only applies to specified implementation expenses. Items not covered include consultancies, training and foreign procurement. The Stocktaking Mission was not able to obtain exact figures on the GOU disbursements. The payments should have been released monthly, but there have been some delays.

The original IDA and GEF budget was USD 25.2 million. The revised budget after SDR exchange rate losses amounted to USD 23,073,000. Expenditure up to the end of March 2003 was USD 22,371,000. It can be expected that the remaining funds were spent by the time of the Stocktaking Mission visit in June 2003. Activities have therefore come to a virtual standstill because the supplementary credit is not yet available.

A Supplementary IDA Credit was agreed upon in July 2002 of USD 4.5 million. It should have covered the costs of the two year extension period up to mid-2004. Official clearance from the Bank came in November. There is a Ugandan requirement that the credit be approved by the Cabinet and Parliament in order to fulfil the Bank requirement for a legal opinion. Cabinet approval came in January 2003, and it was sent to Parliament in the first week of February. At the time of the Stocktaking Mission in June 2003 approval was still being sought from a Parliamentary Committee, after which a resolution will be submitted to Parliament. This delay has led to the virtual stop of project activities. The funds were expected to be used for the two year extension period, and will now be required to be disbursed at a very high rate over a period of one year or less when approval finally comes.

Procurement has followed the GOU and Bank requirements. The procedures are lengthy. The Bank is involved in giving "no objections" throughout the process of all good purchase over USD 50,000, and is involved in the contracting of all consultants. Following the correct procurement procedures has not been a problem, but there have problems with purchase of the wrong equipment and an unsuitable boat for fisheries research. The problem appears to be not making and checking the correct specifications, and a lack of effective communication between the Secretariat and the implementing agencies.

Audits have been carried out in accordance with GOU procedures. They have been done within the time limits set by the Bank.

The delay in having the Supplementary Credit approved in Uganda is a disturbing sign. It looks as if it will take at least five months to get it through Parliament. This indicates that Parliament does not consider it a priority, and perhaps also that the project does not enjoy a sufficient degree of political understanding and support. This is surprising considering that the project must be well known after six years in operation.

7. LESSONS LEARNED

The following general conclusions of the Stocktaking Mission emerge from the experience of LVEMP 1 – and they are selected in as much as they have a bearing on the planning of LVEMP 2. Conclusions related to the individual components are presented in the specific component reports.

- Consideration should be given to ensuring high level accountability and coordination of the project through the creation of a National Policy and Steering Committee.
- Consideration should be given to placing emphasis on the coordinating and facilitating roles of the NES, rather than on direct leadership.
- Project design should identify the high priority issues in relation to environmental management of the Lake, and then concentrate activities in those areas.
- Project design should be based on a Logical Framework Approach that conforms to international standards and which is understood and used by all project professional staff.
- Project design should include a few outputs and process indicators for the functioning of the Secretariat. Total administration costs should be restricted to 10-12% of the budget.
- Project design for LVEMP 2 should include a sustainability strategy for the Secretariat to come into effect when external support terminates.
- Project design should prioritise the role of the Secretariat in data management with the focus of collating and synthesizing data into an annual State of the Lake report. In addition, data should be collected and analysed only in relation to a clear Management Information System that delivers the appropriate data to relevant decision-makers.
- Project activities should be coordinated with the work programmes of projects funded by other donors.
- Capacity building should be more strategically driven and based on a training needs assessment conducted in the light of project priorities.
- Guidelines on reporting formats should be developed – for use by both the project and the Bank.
- In a project that is not only concerned with the collection and analysis of scientific data – but also with raising public awareness and influencing management decisions – care will need to be taken that publications are tailored to the needs and levels of the intended readers.

GENERAL INFORMATION ABOUT ARUSHA TOWN

1. **Background**

Arusha is halfway, between Cape Town and Cairo, straddles Mount Meru, in the land of the Massai. Formerly an old trading post, Arusha today is the administrative centre for a large and important area, producing Coffee, Wheat, Sisal, Pyrethrum, Sugar, Textiles, Dairy products and Horticulture. It is also the country's Tourist centre due to its close proximity to Serengeti, Ngorongoro, Lake Manyara and Mout Kilimanjaro National Parks.

2. **How to reach Arusha**

Kilimajaro International Airport is a 40-minutes drive Eastward to Arusha Town.

From Uganda one can fly directly to Arusha on Air Tanzania (in joint partnership with South African Airways). You can also make flight connections via Nairobi or Dar-es-Salaam, which have flight connection with Arusha.

3. **Accommodation**

Accommodation in Arusha is available in any of the following hotels:

HOTEL NAME	RATES	TEL. NUMBER
1. Novotel Mount Meru		2508320/2508804/508737
2. Impala Hotel		2508449/2508451
3. New Arusha Hotel		2508541/5
4. New Safari Hotel		2503561
5. Hotel seventy-seven		2508054/2503802
6. Mountain Village Lodge		2502699/2502799
7. Arusha Resort Centre		2508333
8. Hotel Dik-Dik		2508110
9. Hotel A.M.		2507873/2507816
10. Golden Rose Motel		2508862/2508861
11. Eland Motel		2507868/2508892
12. Manor Hotel		2503750
13. L. Oasis		2507089/0811-510531
14. Ilboru Safari Lodge		2507834
15. Hotel des Moines		Tel. Number to be provided later.

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Rooms may also be rented at the Italian Restaurants, Mezzaluna, Spices & Herbs Ethiopian Restaurant etc. For more information, please contact the Tanzania Tourist Board Information Centre; Tel: 007-27-2503842/3, Fax: 007-27-508256, Arusha.

4. Restaurants

There is a growing number of good Restaurants in Arusha Town. All hotels have Restaurants within their premises. In addition, there are Chinese restaurants, namely; Everest, Shanghai and Mandarin, Italian Restaurant Messaluna, an Indian Tandor Restaurant, Massai Camp, a quasi – Mexican outfit, chez nany French restaurant, Spices & Herbs, Ethiopian Restaurant and several small establishment with local dishes and ever present "nyama choma"- charcoal grilled meat barbecues.

5. Shopping

The main shopping streets are Sokoine and the road between the Clock Tower and Goliondoi. Here you can find "makonde carvings". Batiks, Maasai bead necklaces, meerschaum pipes and Gemstones – the famous Tanzanite Gemstones are also available.

6. Recreation

The New Arusha Hotel, Novetel Mount Meru, Hotel Tanzanite and Dik-Dik, have good swimming pools which visitors may use at a small fee – (no charge to hotel residents). Boating and fishing is available by arrangement, during weekends, at Lake Duluti. Golf and Tennis courts are available at the Gymkhana and AICC Clubs. There is a Casino in town one may dance to live and disco music at several places, including Hotel seventy seven, Heart to Heart Club and the Mawingu Club.

7. Worship

There are several Temples, Mosques and Churches, to cater for most of the world's main religions. Although most services are conducted in Kiswahili, the Anglican Church, Catholic Church and Holy Spirit Church, have special services in English.

8. Transport within the Town

There are Taxi services in various parts of the town. However, for more reliable and secure service, it is advisable to inquire at your hotel reception.

various comments from governments. You will find enclosed, the following copies of reports:- The National (Uganda) Stocktaking Report; the Scientific Stocktaking Report by Prof. Robert Hecky; and the Vision and Strategy Report for Lake Victoria Basin. **Please send in your comments, if any, to the Secretariat not later than Monday 11th August, 2003.**

The main other purpose of writing this letter to you is to formally inform you that you have been selected to be among the group of people that will travel to Arusha for the workshop. The group will leave for Arusha on 7th September 2003 and return home either on 11th or 12th September, 2003.

The Project will be responsible for your travel and daily subsistence allowance for the period of your stay in Arusha, the workshop. You will, however, be responsible for finding your own accommodation and for all local transport such as from Kilimanjaro airport to and from Arusha town, and daily from your hotel to the workshop venue. A brief information guide about Arusha town is also enclosed. As there will be many people in Arusha that week, you are advised to make your own advance bookings using the hotel telephones provided.

Any further information on the final arrangements will be communicated to you in due course.

John T. Wambede
OPERATIONS OFFICER
For: **NATIONAL EXECUTIVE SECRETARY**

Enc.